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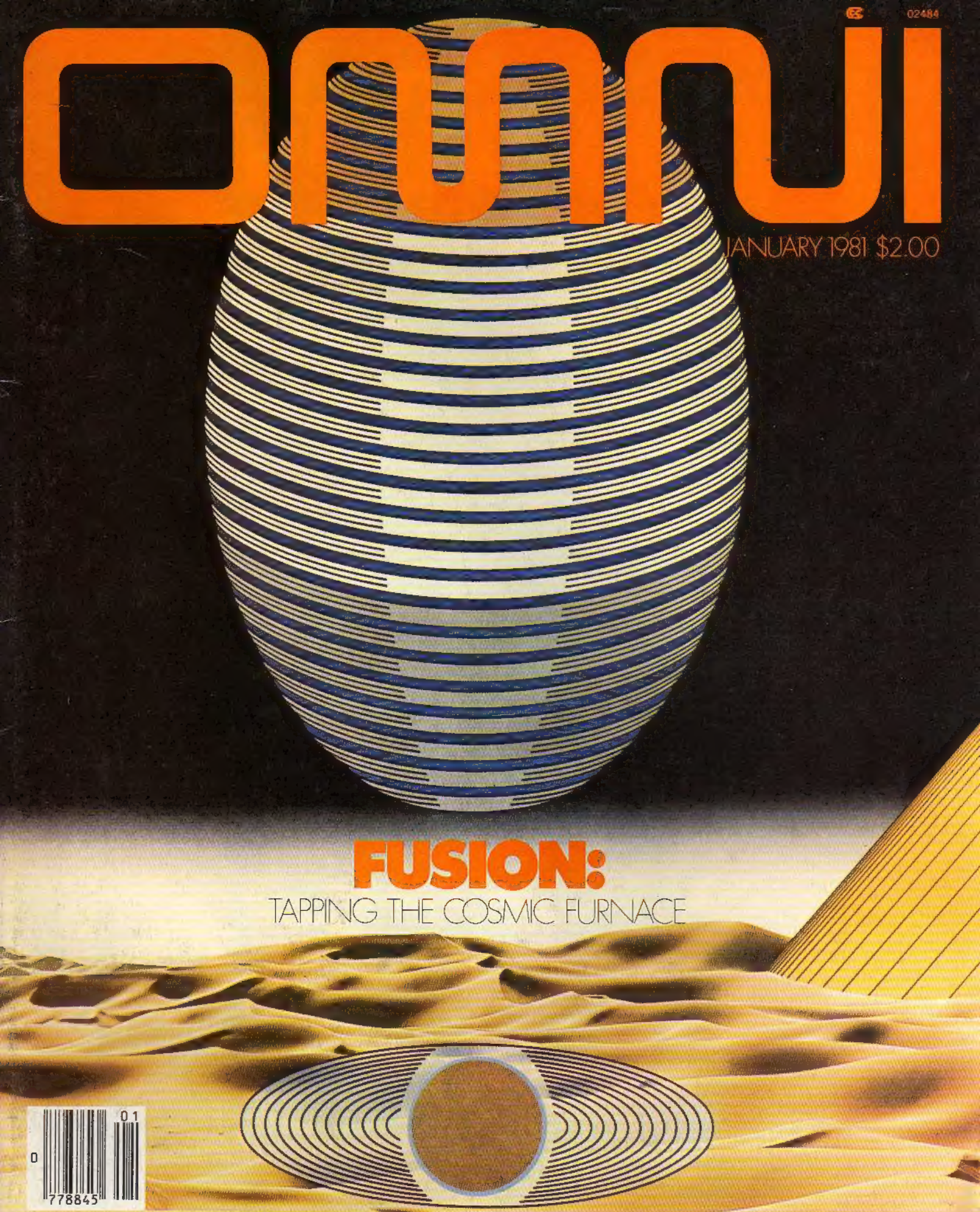

FUSION:

TAPPING THE COSMIC FURNACE

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OMNI

JANUARY 1981

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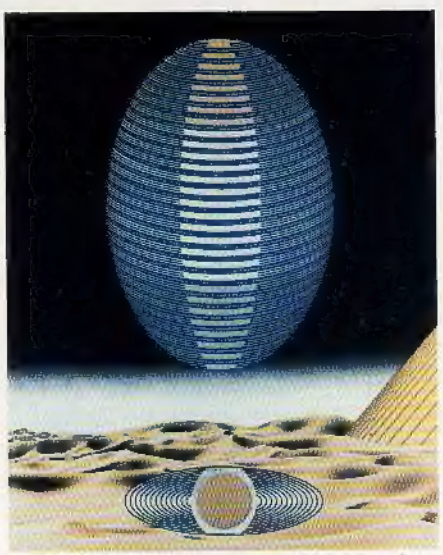

The highly stylized art of Japanese Kazumasa Nagai is featured on this month's cover. Linear, computerlike patterns superimposed over realistic landscapes are indicative of Nagai's unmistakable style, and exemplify Japan's current trend toward surrealism.

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FIRST WORD

By Robert Anderson

"Media emotionally reinforce the simple answer while suppressing the insight necessary for a complex technological society."

One of life's ironies is that, as our modes of communication become more sophisticated and far-reaching, the messages they carry become more simplistic and restricted.

Be it television exposé, radio news show, or printed investigative report, each aims at a wide audience under the restrictions of air time or print space. Each tries to simplify its messages in order to hold the interest of an audience whose education and experience are as broad as the human spectrum. As audience size increases, message content reflects little intellectual analysis, relying instead on emotional appeal. The result is that the media reaching the greatest number of Americans carry messages often designed to reinforce emotionally the simple answers while suppressing the insight necessary for decision making in a complex technological society.

Two words often maligned in this phenomenon of reduction to simplicity in communications are *future* and *profits*. Because each term encompasses many possible causes and conditions, the use of emotional appeal devoid of any intellectual insight has a misleading, mistaken, and often destructive result. The effect is often, at best, a composite misrepresentation, as in "the promise of the future," or, in the worst case, an emotional bias, such as "excess profits."

An even greater injustice resulting from the spread of simplistic information is that the media, unable to deal adequately with the terms *future* and *profits*, cannot deal with the relationship between the two.

Before we begin to understand this relationship, we need to consider current concepts of *future* and *profits*.

Most of us use two methods to view the future: through historical extrapolation or through fictional presentations.

Historically, we can detect patterns of growth and development in science and technology. We see a colony of tinkerers develop into a country of inventors, then into our world community of scientists and engineers. We can predict where we expect to be in the year 2000 by using information such as energy availability and the opinions of experts concerning the avoidance of nuclear war. Essentially, this is the "as it has been, so shall it be" theory of the future. We assume conditions and we assume progress. Unfortunately, this theory concentrates only on historical events and not on one of the main driving forces leading to them. This method cannot predict the creative leaps, be they spontaneous or intuitive, that could fundamentally change our future.

Fiction, our second method of viewing the future, invents these creative leaps because they are necessary to enrich the narrative. But fiction, too, has its drawbacks in predicting the future. There are thousands of possible future worlds, but there will be only one factual world. Fiction never really shows us how to get from here to there. And fiction often raises false expectations. For example, how can we appreciate the problems inherent in building the space shuttle after having mentally flown in so many fictional spaceships?

We cannot rationalize the future by using history, nor can we fantasize it. There will be only one future. And we won't predict it, we'll create it.

We create the future by buying it, and we'll get what we're willing to pay for. We buy the future with our time, our brainpower, and the amount of money we spend on it today. If we cut back the amount of time, intellect, and money that we expend on national defense, the space program, or research and development, we cut back our future. If we want progress in the future, we have to pay for it now. The less committed we are to creating the future, the less future we create. But, conversely, the more committed we are to creating the future, the better future we can create.

Which brings us to our second word: *profits*.

Those who think of profits as bags of money sitting in corporate vaults and waiting to be divided up by robber barons are suffering from a severe case of "mass-media-itis." For those who think of profits as what's left over after wages, bills, operating costs, and taxes are paid, perhaps there's hope. Those who see clearly the relationship between what's left over and what we can spend on the future are following the right track.

Profit—in the form of time, brainpower, and money—is a tool, the very one we use to create the future. Research-and-development programs, new plants and equipment, new products and services, and new jobs all come from profits.

Once you see this relationship between profits and future, you begin to understand that there are no "excess profits," because profits are converted into tools to create the future.

Earlier I mentioned that when we view the future through historical extrapolation, we ignore one of the main forces that drove our historical progress. One of these forces is our felt need to improve ourselves, by profiting from experience, from mistakes, and from investment. The question is, Do we want to *continue* to improve our science, our technology, our arts, our way of life?

Without profits, you might as well tear up your ticket to *Star Wars III*, burn your *Omni* magazine subscription form, and forget about next year's novel by Asimov, Niven, or Sturgeon. These won't exist without the promise of profits.

But that's probably just as well, because without profits as a tool to create the future, it's only frustration to dream about it. ∞

Mr. Anderson is chairman of the board and chief executive officer of Rockwell International Corporation, headquartered in Pittsburgh.

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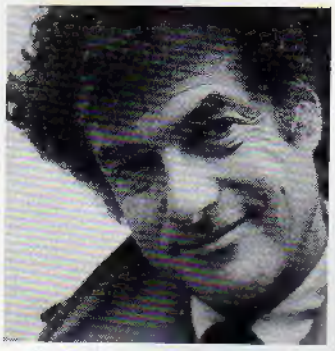
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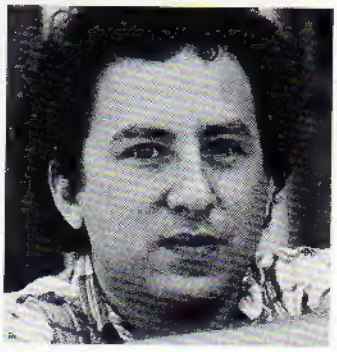
EDELHART

There's no question that if fusion works, it will solve the world's energy problems once and for all. The real question is, Will it work? We understand well enough the physics of a fusion reaction, but time and money must assume generous dimensions if fusion is ever to demonstrate its potential as an infinite source of safe energy. Mike McCormack agrees. Before he was swept from office by the conservative tide last November 4, Congressman McCormack somehow persuaded his colleagues to vote for an energy package few of them even understood. Scientists and engineers for years have attempted to harness the power of the stars, but only recently have they demonstrated the possibility of actually building a fusion reactor. The former representative from Washington State guided a $20 billion program through Congress that guarantees a fusion reactor within the next 20 years.

"It's the most important energy development since the controlled use of fire," McCormack told science writer *Dan Greenberg* in "Fusion Politics" (page 52). But politics isn't the whole story. The business and the science of fusion form other elements in a composite portending the eventual reality of free energy. This month's *Omni* explores the implications of an alternative so profound we'd better not let it pass us by.

"Small is better," says Robert W. Bussard, whose independent company, Inesco, wants to build cheap, modular, "midget" fusion reactors. These machines could be used up and thrown away like light bulbs. How does Bussard's midget miracle technology stand up to the big fusion establishment? *K. C. Cole* provides the provocative answers in this month's Interview on page 56. Cole is the author of *What Only a Mother Can Tell You About Having a Baby* (Doubleday/Anchor) and of several guidebooks on scientific phenomena. A contributor to, and former editor of, *Newsday* and *Saturday Review*, Cole has also written for the *New York Times* and *Glamour*.

Private industry's development of commercial fusion has been but a drop in the bucket thus far, yet an increasing number of major firms are plunging in as the program swings from pure physics to engineering. The end result? A worldwide fusion economy within 50 years. Former *Newsweek* writer *R. Bruce McColm* profiles the technicians who make it happen in "The Business of Fusion" (page 46).

Mike Edelhart's "Fusion Odyssey" (page 38) depicts a world where limitless energy has become a way of life. Cities, industry, even spacecraft, are powered by fusion reactors. An associate editor of *Omni*, Edelhart has written several books and has had articles published in *New Times*, *TV Guide*, the *Washington Post*, *Writer's Digest*, and elsewhere. He is also a columnist for TWA's *Ambassador* magazine.

This month's fiction includes *Ian Watson*'s "A Cage for Death" (page 94). A 1963 graduate of Oxford University, Watson has lectured at universities in Tanzania and Japan. His first novel, *The Embedding*, won the French Prix Apollo; his second, *The Jonah Kit*, received top honors from the British Science Fiction Association. A novel based on the story "A Cage for Death" is due in the fall of 1981, to be entitled *Deathhunter*.

Also featured is *John Keefauver* ("Body Ball," on page 72). Keefauver has had many pieces published in such periodicals as *National Review* and *Omni*. His work can also be found in several suspense anthologies, including Random House's Hitchcock collections.

The visionary genius of fantastic realist *Ernst Fuchs* is displayed in a gallery of paintings entitled "Divine Alchemist." Art expert *Tom Weyr* explores Fuchs's hypnotic images and subliminal style. See page 62.

Princeton's controversial professor Julian Jaynes is profiled by science editor *Philip Hilts* in "Odd Man Out" (page 68). Hilts, a writer for the *Washington Post*, has profiled many big names, including Walter Cronkite and David Brinkley.

Omni was named Best Magazine of 1980, and Editor in Chief and Publisher *Bob Guccione* was presented a Golden Scroll Award of Merit for Outstanding Achievement by the Academy of Science Fiction, Fantasy, and Horror Films. And our European editor, *Bernard Dixon*, was recently honored with the Glaxo Fellowship Award for his column Talking Science, in *World Medicine* magazine.

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JANUARY

LETTERS

COMMUNICATIONS

Robot Revolution

A long-time advocate of full unemployment, I read with great interest James S. Albus's intriguing article "To Pay for the Future" [October 1980]. The potential of robotics and information-communications technologies to free humanity from drudgery and poverty is wonderful indeed.

The problem Mr. Albus addresses is crucial to the realization of this potential: Somehow we must change the way we distribute wealth so that machine-generated profits can be spread around in an equitable manner. I have held jobs only because of economic necessity and see nothing noble about working for money. Moreover, consider the waste, pollution, and superficiality of lives dedicated to the preservation of our present consumer society. If we got down to creating truly durable goods via robotics and translated much of our hardware into software, we might find that much of our present industrial activity exists only to keep people working at dull and dangerous jobs.

Perhaps the answer lies in beginning to distribute wealth to the tinkerers, inventors, thinkers, artists, poets, and writers, as robotics displaces our citizenry from factories and offices. Wouldn't it be nice if we could all take our doctor's advice to slow down, get outdoors, tend a garden, get more exercise and sleep, and spend our days involved in creative activities? Let's hear more about this topic.

Phil Armstrong
Great Lakes Energy Systems
Boyne City, Mich.

If the robots are coming, then we should heed the Albus scenario as a warning of the tragedy the robotic revolution can bring. Obviously, Albus adheres to the old doctrine that wherever technology pushes them, man and woman will love it.

Horseradish!

Some people would prosper in such a world, true. But most would founder in a civilization of abundance without pecuniary incentive, challenge, or achievement. Sadly, the intellectual pursuits that Mr. Albus proposes as replacements for effort in the workplace simply don't interest many people. Not everyone can be satisfied pondering the heady problems of overpopulation and space colonization. To be fair, of course, Albus does offer the displaced workers the option of becoming programmers and factory workers for the very robots that displaced them, but such work seems little improvement over what Albus sees as drudgery in 1980.

Perhaps most appallingly, Albus fuels our insatiable materialism. He points to unlimited cheap goods as central to the robot revolution. Everything will be so inexpensive, he predicts, that nothing will be worth repairing, or keeping, or using more than a few times. Disposing of the family car when the ashtrays fill will be commonplace.

The robots may be coming. If they are, it's because people are bringing them.

Let's fashion technology in the image of man and woman. Not vice versa.

Rod Ausura
Gaithersburg, Md.

Still a Burning Issue

Your anniversary issue [October 1980] carried a letter concerning the old dilemma of the relative temperatures of Heaven and Hell. It is time that this issue be finally resolved.

In a recent issue of *Journal for Irreproducible Results*, a contributor finally resolved the flaw in the classic dispute. As any high-school chemistry student can tell you, the boiling point of any substance varies with the ambient pressure. Relying on estimates of the number of the damned and on the size of Hell (based on theological calculations), the pressure in Hell may be calculated to be on the order of 10^9 atmospheres. All will agree, I believe, that sulfur will boil at a considerably higher temperature under these conditions.

This should finally put an end to the Heaven/Hell temperature debate.

Arthur S. Harrow
Tempe, Ariz.

Eloquently Put

Omni has lit up my life for a full year now, and I look forward to each issue as a child anticipates Christmas.

My profession is technical writing, and I am continually appalled at the poor use of our language in all forms of communi-

cation. Therefore, I was particularly pleased to read "Torrents of Babel," by Edwin Newman [October 1980].

Caroline Scoulas
Riverside, Ill.

Congratulations to Edwin Newman on his article "Torrents of Babel." If we here in America cannot communicate properly with one another (much less with the other peoples of Earth), how, when the time comes, do we expect to communicate with beings of another kind on another planet?

Anne McKinney
Phoenix, Ariz.

Cotton Balls and Sexual Encounters

As a biologist, I was particularly amused by Isaac Asimov's solution to the population problem [Last Word, October 1980]. However, I have reason to believe that evolving a strain of human beings with periodic-receptivity patterns will not reduce the number of sexual encounters. Not because of the lack of pheromones, at any rate.

I have evidence. Using cotton balls, surgical tape, and volunteers with a taste for the unusual, I have plugged my nose and held my breath before engaging in receptivity-response experiments. Not once, in many repeated trials, was my willingness to respond any different from what it was when I engaged in those encounters without the nose plugs. In fact, I started each trial with the same, if not increased, enthusiasm.

Although these experiments were not performed under ideal experimental conditions, I feel the precautions and procedures mentioned above shed doubt on Mr. Asimov's proposal. Another solution for the population problem will have to be sought. Better luck next time!

John J. White
Tennessee Technical University
Nashville, Tenn.

Space Groups

I am interested in contacting several of the space organizations frequently mentioned in *Omni*. However, their mailing addresses are not readily available.

Maybe a small space in each issue devoted to these organizations and their addresses would enhance the revitalization of our space efforts. I'd like to be able to colonize in space before I die.

Dennis A. Maguire
Andover, N.H.

We agree. A comprehensive listing of grass-roots organizations for space will appear in our next issue. —Ed.

Lobbying for Space

Although the 1980 election is now history, I hope enough people took David G. Webb's advice [Space, November 1980]. It's up to us to put into office people who will push through bills to aid our ailing space program.

We can't wait around forever, or even for very long, before this planet's natural resources are exhausted. We must start immediately to explore the beyond, in depth, before we are forced to import materials that can be ours.

The next election for the House of Representatives comes in two years. So let's get involved and help get the right people into office, people who recognize where our future lies.

Mark Vitali
San Diego, Calif.

Music for the Ages

I thoroughly enjoyed the fine article "Video Music" [The Arts] in the October 1980 issue of *Omni*. I have always felt that *Omni* has done more to promote concepts not widely understood than any other magazine. The format is easy to follow, and *Omni* has, I think, the ability to contact the best-known authorities on any subject needed.

I am a student at Boston University, now in my second year of computer engineering studies. For the longest time I had no idea what I was going to do with my education after graduation. Computer graphics at first appealed to me. After some further thought, I have been considering a career in electronic studio techniques. But not until I had read your article did I think of combining the two without compromise. Now I see that this is very possible.

Maybe someday someone will come up with a better name for "video music." Until then, I wish John Whitney further success in his work.

Pedro Gerardo Silva
Boston, Mass.

Divine Principles

As an occasional reader, I thought the second-anniversary issue of *Omni* was very informative.

As a Christian fundamentalist, however, I disagree with what appears to be your general philosophy (that science and technological advance will not only save us from ourselves but offer us a "better tomorrow"). I find this humanistic view light-years away from the truth. We should consider those highly advanced civilizations that fell, regardless of their extraordinary technology. Their social/moral decay, along with other contributing factors, terminated their existence. Many of those factors are becoming evident today in our own international society.

I won't bore you with my own theological convictions, except to state that I believe certain divine principles of behavior (not found in today's textbooks) must not be ignored if we are to survive (decently) the next quarter century. Though science is vitally important to our society, its own finite efforts cannot safeguard a Tomorrow, good or bad. Beyond our limited perception and scientific endeavor, we must rely on mere faith that [God] is the only plausible answer to our plight. And we do have a plight.

Dana M. Groff, Jr.
Tampa, Fla.

Wright or Wrong?

Whenever I hear "scientists" arguing about the credibility of a phenomenon ["Scientists and Monsters," Continuum, August 1980] that manifests itself through only, at best, sketchy proof, I recall an inspiring story.

It seems there was a famous bishop in the 1800s who was considered one of the foremost authorities in science and theology. His name was Wright.

One of his sermons was widely reprinted in many newspapers in the northeastern United States. The sermon suggested that man had discovered just about all there was to be found and that now it was time to relax and ponder the fine points of all these discoveries.

At the time Bishop Wright had just baptized the younger of his two sons, whose names were Wilbur and Orville.

During a darker period of my intellectual growth I used to proclaim myself a "realist," until I saw this to be a very naive state of mind. But how safe it was . . .

J. S. Todhunter
Fountain Valley, Calif.

Plucked from the Abyss

After witnessing the paranoid spectacle of the Department of Energy making sound and video tapes of American citizens exercising their constitutional right to free expression, I want to express my appreciation of your interview with Denis Hayes, of SERI [August 1980]. It's refreshing to see that at least one government agency is making wise and effective use of its funding, for a change. Mr. Hayes seems to be a very intelligent, articulate, and sensible person. These qualities are in short supply in our rather wasteful bureaucratic structures. I think it's productive people like Hayes who will play major roles in plucking our planet from the edge of the abyss.

Alan Brookstone
University of Colorado
Boulder, Colo.

Source of Nebulae

The photographs of nebulae reproduced in your November issue from my book *Galaxies* were not attributed to the scientists and institutions that created them. Readers interested in the sources of these lovely photos will want to know that they are: page 92, David Malin, Anglo-Australian Telescope Board; pages 93 and 97, Hale Observatories; pages 94 and 95, Royal Observatory, Edinburgh; page 96, Association of Universities for Research in Astronomy, Inc., Cerro Tololo Inter-American Observatory.

Timothy Ferris
Hollywood, Calif.

DIALOGUE

FORUM

In which the readers, editors, and correspondents discuss topics arising out of Omni *and theories and speculation of general interest are brought forth. The views published are not necessarily those of the editors. Letters for publication should be mailed to* Omni *Forum, Omni Magazine, 909 Third Avenue, New York, NY 10022.*

Equal Time for Creationists

I applaud Ben Bova's piece on the creationists [Continuum, October 1980]. Since the rise of science, there have been those who have chosen to reject its findings because of their religious or philosophical prejudice. With the recent rise in political activism among fundamentalists, their attempts to influence education have intensified.

Many groups advocating "equal time" for the creationist viewpoint would have us believe that this is purely a secular matter concerning a balanced approach to a controversial topic. It is obvious, however, that their true objective is a revival of Christian cosmology.

It is disconcerting to note that the movement has some chance of success. A society that gives open-armed acceptance to such notions as ancient astronauts, pyramid power, and astrology cannot be expected to scrutinize creationism with an informed or skeptical eye. There is no evidence that state legislators or school-board members are any more capable of resisting this retreat from rational thought than private citizens. This may be why the creationists have chosen to advance their ideas by means of public propaganda. Clearly, the appropriate forum for the resolution of a scientific controversy is in the relevant scientific journals.

The scientific community must speak out on any relevant topic that captures the interest of the public. The principles and processes of science must be made clear to society at large. Writers like Mr. Bova play an indispensable role in this effort. I look forward to reading his columns.

Steven C. Haack
Lincoln, Neb.

I object to the way in which Mr. Bova has misrepresented creationists' objectives in having creation taught in schools. A Christian is a lover of truth and despises obvious lies, such as evolution, especially when such lies are incompatible with the truth of God's existence. Anyone who has studied evolution even remotely soon realizes that the theory cannot include God: Theistic evolution is totally illogical. The influences of evolution have already had horrible effects on society. To continue teaching a theory that stands on exceptionally shaky ground is extremely unscientific.

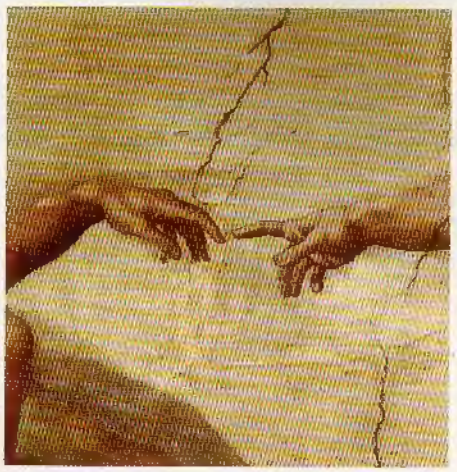
Evolution is a theory that arises, not out of evidence from the earth, but out of man's determination to deny God's existence. Evolutionists desperately seek other answers.

I find it distressing that *Omni* has gone along with the misinformation passed down through the years. Why not run a debate between a creationist and an evolutionist? Let the readers decide for themselves which represents truth.

Craig Miller
Arlington, Tex.

Ben Bova, I love you. Your editorial, "The Creationists' 'Equal Time,' " to my mind, was the most refreshing and most inspiring article written in eons. Refreshing from an intellectual standpoint and inspiring because I was beginning to think that there weren't any more human beings out there who still believed in rationality—in reason as proof over unproven mysticism. I salute *Omni* for having had the insight and courage to print such an article.

Hillary A. Bornor
Oakland, Calif.



Michelangelo: Illustration for a biology text?

I feel that I must comment on Ben Bova's article on creationists in *Omni*'s October 1980 issue. I am a scientist, and I believe that biologists must go on gathering evidence and refining their theories. I am also a Christian, and as such I believe in the Bible and the divine creation of man.

I see no conflict between these two views. As a scientist, I must accept the evidence that points to evolution, but, as a Christian, I cannot help believing that God directed this evolution. The Bible does not say how God created man. It only states that He did it. If evolution was the method, that is fine and does not bother me. I find it hard to believe that such a world could evolve without some form of divine guidance.

Arthur S. Bland
Albuquerque, N.M.

Bravo, Mr. Bova! Your article on the creationists in *Omni*'s October 1980 issue expressed thoughts that I have long entertained. Unfortunately, the creationists appear unable, or unwilling, to question the written word. Remember, please, that the word was written by man, a fallible creature indeed. Thank God (oops) that biologists are willing to question what they are told, that they do not take everything for granted. (Creationists call this faith.) If we all failed to question, nothing new would ever be learned.

Let us be thankful that there are those who do question "accepted facts" and "obvious truths." Any true biologist would welcome proof that his or her particular theories were wrong if the scope and knowledge of science would be advanced. I am tired of having "faith" flung in my face. If proof of creation, or

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TERRA INFIRMA

EARTH

By Kenneth Brower

The first alien scouts to look down on this planet are likely to be a hard-nosed bunch, if they have noses at all. A safe assumption is that they'll at least be *tougher* than the inhabitants of the lush, blue-green orb below them. From all that we can perceive of our galaxy, life is no picnic out there.

And yet I'll lay odds that their first reaction will be one of surprise.

"The whole planet's alive," a lieutenant will say, in rough translation, as he adjusts the screen of a life-form detector. He will shake his Spartan head, or heads, in wonder. "The entire surface of this globe is a superorganism."

Like all diagnostic equipment in use on their world, the aliens' life-form detector resembles a seismograph. The machine will register a wiggly line encircling the earth's relatively inert, peaceful core and crust—an epidermis of life. The line will be scratchy and discontinuous over the oceans, where life is dilute. It will track thin over deep deserts and over the poles, where life is sparse. But over the soil-coated continents, the line will jump and jerk while it monitors the diversity of the life teeming within.

These extraterrestrial scouts will be hard pressed to believe that the soil they find here is not a superorganism. It breathes through pores burrowed by worms. (In good soil during one growing season, 50,000 worms will overturn about seven tons of soil per hectare.) It's alive with bacteria and fungi, and sowbugs and centipedes lace their way through it. It slithers with worms. Occasionally it shudders with the passage of a mole.

The diversity of species that aerate, refine, and renew the soil disqualifies soil as a superorganism—by most earthly definitions. The soil's great age alone is far more ancient than any beehive or termite mound. Its growth is excruciatingly slow, a centimeter every 150 to 500 years. In the nutrient-rich layer known as humus, organic molecules 3,000 years old are still on the job.

These dark brown organic macromolecules form the basis of almost all life on this planet. And yet one of the soil's more singular productions, humankind, has been at war with those mother macromolecules throughout its entire history.

Human presence can be interpreted as a withering of landscapes—an accretion of ruined Edens. Mesopotamia, that once-rich land where 6,000 years ago our sapience produced the wheel, is now the wasteland we call Iraq. The United States, cradle of the modern civilization that produced the digital watch and put a golf club on the moon, annually loses nearly 3.5 tons of soil per hectare. We are a "humuscidal" animal.

President Carter asserted in a recent speech that in 1935 the United States had "well over six hundred million acres of actual or potential cropland." In the following 45 years, "one hundred million of those acres [were] effectively destroyed." On the soil that remains, we are producing more crops than ever before. But to achieve this abundance, we are poisoning those precious remaining acres with pesticides, fertilizers, and salinization. By "mining" the soil, we plunder the land and steal from our descendants. The dream of converting biomass into alcohol and gasohol is built upon a soil profile that is steadily diminished each year.

Like so many of our schemes, biomass conversion is a shortcut. The idea is to harvest crop residues and leaf litter rather than to wait millennia for ferns and diatoms to compress into coal and oil. It is a technically ingenious plan, but ecologically horrendous. The soil needs that leaf litter and crop residue. Humus requires the constant addition of new decaying biomass to maintain itself. Wherever the biomass harvesters wander, the organic component of the soil would be impoverished, and carbon and nitrogen cycles in the soil would be disrupted. Biomass conversion is a way of taking still more from the eroding landscape and giving even less back. The hitch in the dream of driving on gasohol to the supermarket is that, when you arrive, there may be no bread on the shelves.

Soil is overdue for a revolution in the way we think about it. Part of that revolution will manifest itself in a return to organic farming and the nonuse of chemical

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BRAIN MENDING

LIFE

By Kathleen McAuliffe

When a vital tissue or organ becomes defunct, cadavers and prosthetic devices are the logical places one would turn to for spare parts. Neither avenue is possible for victims of brain lesion. Their disability results from the death of tissue in a small, confined portion of the brain, often no larger than a grape. But some of these people could benefit from a novel, though controversial, type of organ bank.

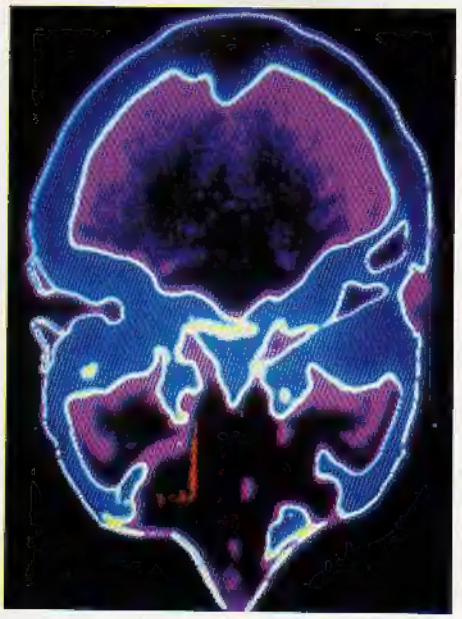
Embryos, including human embryos, might become an invaluable source of brain tissue for transplantations. This is the impact of research conducted by Barry Hoffer, of the University of Colorado; Richard Wyatt, of the National Institute of Mental Health (NIMH), in Bethesda, Maryland; and Lars Olson, of the Karolinska Institute, in Stockholm. While older animals' brain tissues rapidly degenerate when placed in foreign surroundings, embryonic cells have no trouble adapting to a new abode. The researchers extracted brain cells from a rat fetus and implanted them in a comparable region of an adult rat's lesioned brain. Instead of dying, the cells continued to develop normally and grew into the host's neural network.

But embryonic cells are more than good colonizers. They are skilled pathfinders, and this talent is crucial in repairing lesion damage. Confronted with millions of crossroads, called synapses, fetal cells seem to have no difficulty finding their way to the target area. Indeed, even when implanted off course, they have an uncanny way of reaching the destination that nature intended. The navigational feats of birds and fish are tame by comparison.

Already Hoffer and his colleagues are using embryonic grafts to alleviate the symptoms of lab-induced Parkinson's disease in rats. For both man and rodent, the disorder is caused by a lesion in that part of the brain responsible for producing dopamine, a substance essential for normal motor control. The scientists transplant tissue from an area of a fetal brain that corresponds to the site of the lesion in afflicted rats. Approximately two thirds of the cells survive and establish interconnecting links with a neighboring neural center. As dopamine levels begin to rise, the rats show a decrease in behavioral abnormalities associated with the disease.

"We've now examined the grafts for about a year, which is almost half the life span of a rat," Hoffer says, "and there appears to be no rejection." How do they escape detection by the host's arsenal against foreign invaders? The secret lies in the brain's blood barrier, which screens out antibodies and other lymphatic cells. As far as the body's immunological system is concerned, the brain is neutral territory where foreign grafted cells can coexist with the local inhabitants. The eyes, too, share the brain's special status of being "immunologically privileged," thereby raising hopes of someday grafting new eyes for the blind.

Much closer to realization, according to Hoffer, is the prospect of using fetal implantations to cure certain forms of brain impairment that involve a focal loss of neurons. Besides Parkinson's disease and Huntington's chorea, numerous disorders of the hypothalamus are subsumed in this category. Results from experiments now being done on primates will prove crucial in assessing the clinical utility of this procedure. Even if scientists are successful beyond their wildest dreams, however, the path from monkey to man may be strewn with moral obstacles.



Brain lesions may soon receive cell implants.

"Where are we going to get the embryonic tissue?" asks William Regelson, of the Medical College of Virginia. "You'll have to use a living human embryo. An aborted fetus won't do. Are women going to become impregnated to provide embryos? We're faced with a very serious problem, and we'll have to find ethical alternatives to it. For example, if we can develop the technology to grow embryonic cell lines in culture, that might provide one solution."

Likewise Hoffer, for ethical reasons, rules out using living embryos. But given no other options, he thinks aborted fetuses could indeed supply the donor material. To obtain the fetal tissue, he foresees no need to modify abortion techniques now being used in hundreds of clinics.

Still, abortion itself presents a moral dilemma for many people. Hoffer would much rather find a substitute for the embryonic donor altogether. In the case of Parkinson's disease, he may already have succeeded. The peripheral nervous tissue of an adult, he believes, could serve the same function as embryonic brain tissue.

"Luckily, nature has been parsimonious," Hoffer remarks. "Dopamine acts as a neurotransmitter in the brain, but it is also used in the peripheral nervous system, for example, in the adrenal glands." When adrenal cells are used as the graft material, Hoffer found that "they become more nervelike and send out branches that can actually grow into the recipient's brain." This strengthens the possibility that Parkinson's victims might supply their own grafts by donating a portion of their adrenals.

For other brain disorders, nature may not be so parsimonious. If vital neurochemicals are not present in the peripheral nervous tissue, the embryonic

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BRING ME SOME STARDUST

SPACE

By Jerry Grey

The next best thing to going there is having someone bring back a present. In planetary science, that "someone" must be a robot. Planetary return missions were once among NASA's most promising research. Today they are among the most neglected.

The material our Apollo astronauts brought back from the moon showed what actual samples can do: It told us the moon's age and revealed its chemical composition. And that told us about the moon's early years, including the temperatures and pressures at which it formed, the level of volcanic activity, the energy available for lunar evolution, and even the nature of the solar wind.

Planetary scientists need that sort of information as badly as selenologists do. Our missions to the planets, valuable and spectacular as they are, have not been able to provide it. Even the two Viking probes, which analyzed Martian soil samples and relayed those data back to Earth, could not answer the key question: Is there life on Mars? Viking's robot instruments could not perform the sequence of experiments that turned out to be needed.

Those experiments could be done by human technicians easily, but NASA's dreams of a manned flight to Mars went down the tubes in the post-Apollo depression. The Soviet Union still plans a Mars voyage, but the trip will probably not occur before 2000.

Instead, however, we could bring some of the planet here. The Russians showed the way by retrieving lunar samples nearly ten years ago. A planetary return mission costs more than a lander, but it would be far cheaper than a manned flight. The hardware prototypes for a Mars return mission have already been built. All that's missing is a commitment to the project and the money to pay for it.

NASA's Jet Propulsion Laboratory has suggested two ways to return samples from Mars. In one, a sample carrier launched by the shuttle lands on Mars, collects some soil, and returns directly to Earth orbit. In the other, the returning sampler meets a transport vehicle in Mars orbit, and the transport vehicle then carries the samples home to Earth.

The "direct entry/direct return" approach is simpler, but the Mars lander's return rockets would have to lift it out of the planet's gravity well. To keep its weight down, the rest of the probe would have to be simplified; it could grab only a random sample from an unselected landing site.

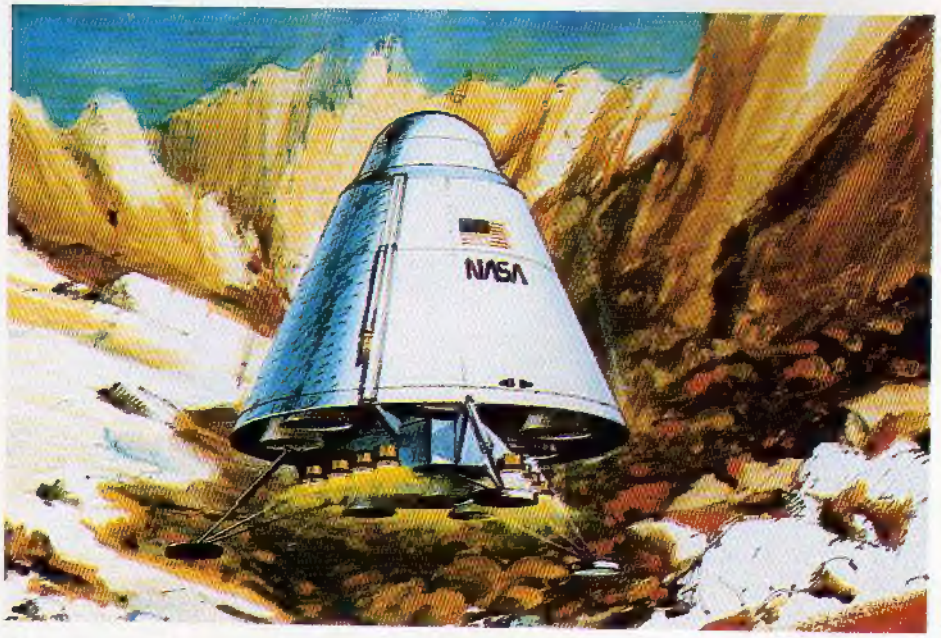
Since both techniques use conventional rockets for the trip to Mars and back, both methods would require at least two shuttle flights to place the hardware into Earth orbit. The direct-entry mission might even need three. But the orbital-rendezvous mission could use ion rockets for the transport vehicle (they are too fragile to land on Mars); in this case, a single shuttle flight could do the job. In either case, the price tag in 1978 was about $1 billion, plus the shuttle costs.

The outer planets would be even more difficult. They are so far from the sun that solar-powered ion rockets would not work, and even high-performance chemical rockets are probably impractical. And the atmospheres of Jupiter and Saturn are probably too inhospitable for a lander to survive. We'll learn more about that during the Galileo mission, which will probe Jupiter's atmosphere in the mid-1980s.

There is one outer-planet mission that might be practical, however: a sampling probe of Titan, Saturn's largest moon. Titan has a relatively dense atmosphere and is now considered the most likely home of life in the solar system, other than Earth.

Another possible mission, one with more than just scientific interest, is a sample return from the asteroids. Laden with metals, organic compounds, and water, the asteroids might be an endless source of raw materials for space industry. The knowledge gained by analyzing an asteroid sample would be incalculable, with enormous economic value.

For today's planetary scientists, however, the idea of bringing home a piece of any planet is only a wistful dream. Unless the United States pulls itself together to rebuild our space program, there's little hope of realizing it. Let's hope that Congress and the administration will soon see the light.



Is there life on Mars? A sample-return mission might be the easiest way to find out once and for all.

PLEASURE MACHINE

MIND

By David Cohen

Psychological theorists once considered pleasure an important catalyst of human action. It was so influential that Freud elevated it to principle, arguing that all human life is a struggle between the instinct the attempt to get as much pleasure as possible and death instinct, the wish to give it all up and return to dust.

Yet during the past two decades pleasure has suffered a period of neglect. It was too abstract a concept for experimenters. They could gauge the effects of tangible rewards like offering a research rat pellets of food or the opportunity to mount a willing female. But pleasure itself remained difficult to define—one person's pleasure being another's pain—and it was a so impossible to quantify.

The coup de grace to science's positive perception of pleasure came from the work of sexologists William H. Masters and Virginia E. Johnson. These physiological experimenters persuaded subjects to make love in the lab. From their work came remarkably interesting measures of penile erection, vaginal dilation, contractile power, blood flow, and other purely physical responses. But not one word about pleasure. Though Masters and Johnson never suggested that pleasure didn't play a part in sex, their approach focused exclusively on physiology.

Today, however, pleasure seems to be making a comeback. Researchers Randy Thomas and Tim Brock of Ohio State University have developed a machine that measures pleasure. The device is a variation of Stanley Milgram's famous pain seat. Instead of delivering the vicious electrical shocks that Milgram required for his study of obedience, however, the pleasure machine treats sitters to exquisite sensual vibrations.

The subject sits on a pad placed in the seat of a comfortable chair. At the touch of a button, the pad produces undulating nirvana. Subjects in Thomas and Brock's surveys rhapsodized about the intense pleasure of the feelings they received. In one test, subjects were allowed to give themselves the experience by pressing the button that set the seat vibrating. Some hedonists the researchers discovered, hogged more than 15 minutes of absolute personal pleasure. Then the scientists had trouble persuading them to stand up and go home.

But the question Thomas and Brock wished to address with their chair wasn't self satisfaction. They wanted to explore the patterns of pleasure giving between strangers. To this end, they adapted the format of Dr. Stanley Milgram's classic experiment in obedience. In that test Milgram asked subjects to deliver what appeared to be dangerous and sometimes fatal electrical shocks to strangers. He found that few refused.

The Ohio State team, by contrast, offered strangers the opportunity to give pleasure to one another. Thomas invited subjects to his lab, showed them the pleasure machine, and then told them they would have a chance to deliver intense pleasure to someone just by pressing a button.

Thomas and Brock found, to their surprise, that far more people refused to give pleasure than refused Milgram's offer to give pain. Ten percent of the subjects stalked out of the lab saying that the experiment was dirty, immoral, and beneath their dignity. Of those who did take part, Thomas reported, most enjoyed the experience. One man said, "It's a unique way of getting to know people" by giving them a bucket full of pleasure.

Would you offer ecstasy to a total stranger?

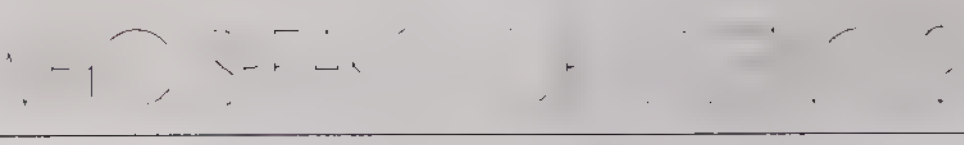
The Ohio State study found that certain rules seem to apply to pleasure giving. If, for instance, the person in the chair is perceived as being of high social status, he gets more pleasure than others would. Also, pleasure giving works better with heterosexual pairs. Men gave women more intense and longer bouts of pleasure than they gave other men. And women were just as conventional. They preferred to press the button for men rather than for other women. Thomas also asked subjects to rate how attractive the person in the pleasure chair appeared, he found that the more attractive the person, the more pleasure he or she received.

One doubt dogged the Ohio State experimenters. Could their research be invalidated if the subject and control gave each other pleasure before being tested? Dating couples, Thomas reasoned, had the chance to give each other real pleasure, body to body, rather than artificial pleasure button to button. So, he thought, dating couples might scoff at the machine. Not at all. Dating couples spent more time giving each other pleasant vibrations than did all other twosomes. Clearly, the more intimately people knew each other, the more reciprocal pleasure they were willing to offer.

Some social scientists have predicted a future of impersonal sex in which the human race has abandoned carnal pleasures in exchange for being seduced and caressed by all kinds of electronic wonder devices. The experiment in Ohio suggests, however, that part of the good derived from the pleasure machine is the joy of knowing that another human being controls the buttons that deliver the right vibrations. Probably, even by A.D. 2100, Thomas concludes, the best pleasure won't come from machines but through interaction between people. ∞

CONTINUUM

Edited by Dick Teresi



Is atomic power essential or too dangerous for mankind to play with? If we burn substantially more coal instead will our planet heat up enough to melt the Antarctic ice cap and create ocean resorts in Kansas?

If you don't feel like deciding these questions how would you like to determine the acceptable amount of low-level radiation exposure for humans? Or the point at which life begins? Or whether gene splicing is a wonder tool or a potential toy for mad scientists? Or what we are really doing to the ozone layer?

Back in the times when a pope could settle the rival claims of two seafaring nations simply by drawing an imaginary line through a virgin continent public policy was more easily made. And in those days even though Copernicus's calculations of planetary orbits might discomfit scholarly clerics science was essentially remote from ordinary life.

Now, however we nonscientists — and the legislators who represent us — are required to weigh issues far more ambiguous than the partitioning of *terra nova* or the movement of the spheres for our society is balanced rather precariously on increasingly complex technology. We are living in a revolutionary age, says Walter Cronkite. "In one generation we have entered three new eras — the Atomic Era, the Computer Era, and the Space Era. Understanding any one of these requires more information than any one of us could possibly have."

Small wonder then that governments sometimes beget strange policies and that we must include tough risk/benefit ratios in our equations. Automobiles, which kill 50,000 of us every year, remain acceptable, although we debate whether saccharin is worth the putative risk of causing even a few human-bladder-cancer deaths each year. Moreover, so many of our problems are global, not just local or national, and an awesome number of the choices we make could have far-reaching consequences.

And where do we get our information anyway? Strong emotions and prejudices, politics and profits color the picture. We are vulnerable to hard sells because so much of our knowledge comes at us piecemeal in packets pro or con something. Hasty skimmed headlines, 20-second TV commercials, and seductive slogans "educate" us about how many billions of mouths world agriculture can feed, the relative dangers of plutonium, waste asbestos in hair dryers, and birth-control pills.

So we mainstream citizens need help. And so does the geneticist when he steps away from bacteriophage mutations to ponder the wisdom of space explorations. But where do we turn for guidance? Who speaks for science? Who has the facts?

Well, there are the long-established scientific, medical, and technical professional societies, for starters. There are voluntary health organizations and government experts with data at their fingertips. And more recently, there has arisen an immense new chorus of voices to catch our ear — sometimes urging specific policies, sometimes warning us of inevitable catastrophe if we ignore its advice. Consumer-advocate groups have proliferated as our lives become more interdependent and as society becomes more conscious of the multiple effects of science and technology on human well-being.

But scientists are political animals, too, subject to feelings, predilections, and ideological leanings. It is the obligation of scientific organizations to identify themselves fully, stating their purposes and any relationships they maintain with industry or government, so that we can better evaluate their contributions. And scientists, says Nobelist Rosalyn S. Yalow, have a special duty to "state what is scientifically known to be fact and to distinguish fact from hypothesis and judgment."

Perhaps it is a sign of the times that one new organization, the Scientists' Institute for Public Information (SIPI), is attempting to gather several conventions' worth of scientists under one roof. Supported by public contributions and occasional foundation grants, SIPI has established a Media Resource Service to give reporters access to several thousand independent experts in fields as diverse as behavior modification, solar energy, lasers, and artificial intelligence. When Cronkite calls in the SIPI people say, they quickly begin given names and telephone numbers of specialists who can explain technical subjects.

Will outfits like SIPI give people more balanced doses of information than they have gleaned from Ralph Nader or the Department of Energy? Maybe so. — *ALTON BLAKESLEE*

SIPI, 355 Lexington Avenue, New York, NY 10017, is kept busy answering a heavy load of calls from the press. "Requests from nonmedia sources must be in writing," says public information director Fred Jerome. — Ed.

CONTINUUM

WOMEN'S BEST-KEPT SECRET

Women are not expected to be able to keep a secret but they guard one vital biological secret better than any other mammal does. According to Dr. James L. Gray, of the State University of New York at Stony Brook, women are unique among female mammals in that they keep their own period of fertility a secret not only from their mates but also from themselves.

In the course of evolution Dr. Gray believes women adopted hidden fertility because it encourages faithfulness in their mates and thus helps them maximize their chances of evolutionary success.

Speaking to the Animal Behavior Society in Fort Collins, Colorado, Gray said that males and females are counted successful in evolutionary terms if they rear many offspring to maturity. For male mammals there are two strategies to achieve this goal: impregnating as many females as possible and avoiding parental care or impregnating one female repeatedly and helping raise her young.

Females also have a choice of two strategies: hiding ovulation and remaining continuously receptive or displaying ovulation and restricting receptivity to the fertile period.

By choosing hidden ovulation, Gray explained, a woman reduces a man's chances of making her pregnant to about 1 in 30 for each copulation, since she ovulates only once a month. To ensure offspring, he has to copulate with her repeatedly over a period of time. Once this investment is made, the best way for a man to ensure survival of the resulting progeny is for him to stay around, fighting off rivals for his ever-receptive mate and helping to care for his children.

Evolutionary success doesn't imply total faithfulness, Gray added, but women's secret fertility means a successful man has to restrict most of his attentions to only a few mates, so that he can impregnate them himself and nurture their young. — Barbara Ford

By keeping their period of fertility a deep secret, says one scientist, women force their mates to hang around, fighting off potential rivals.

ANIMAL MYTHS

In our continuing search for scientific truth, we debunk a few more medieval superstitions.

- Snakes are not slimy; they are dry and smooth to the touch.
- Owls are not smart; they have very small brains and are among the least intelligent of birds. Crows and blue jays are the smartest.
- Toads do not cause warts, they have warts. These warts are not contagious.
- Bats are not blind, they have eyes and can see in daylight. At night they see by emitting a high-pitched screech which bounces off objects and is picked up by the bat's antennae—a kind of sonar.
- Raccoons do not wash their food, they dip it in water to make it soft and slimy so that it will go down their small throats with greater ease.
- Goldenrod does not cause hay fever, its pollen is too heavy to be carried by the wind. The real culprit—ragweed—often grows along with it, but ragweed's inconspicuous flowers usually go unnoticed next to the goldenrod's bright blossoms.
- Dragonflies don't bite; they eat mosquitoes and gnats, not human flesh. They don't sting, either. In olden days their long, thin bodies and fearsome appearance led people to nickname them devil's darning needles. - Stuart Diamond

"One way to maintain your life style when you're getting poorer is to borrow."
— Andrew Tobias

'A new idea is delicate. It can be killed by a sneer or a yawn, it can be stabbed to death by a quip and worried to death by a frown on the right man's brow.'
Charlie Brower

Say good-bye to the idea that owls are wise. They are not very bright, have small brains, and are among the dumbest birds.

TEST-TUBE-BABY CLINIC

An Elizabethan mansion, Bourn Hall is the unlikely setting for the world's first test-tube-baby clinic, which opened this past fall in Cambridgeshire, England.

The clinic is directed by Dr. Robert Edwards and Patrick Steptoe, pioneers of *in vitro* fertilization, whose work was responsible for the birth of Louise Brown in 1978. The fee for treatment at the clinic is £1,680 ($4,000).

Edwards and Steptoe do not guarantee pregnancy. Last year they reported that only 4 of their first 52 implantations had led to pregnancy and that only 2 of those had produced live babies (one of them Louise Brown). Thousands of foreign women are already on the waiting list for Bourn Hall, where 30 patients can be treated at any one time. — Bernard Dixon

"Science fiction is a kind of archaeology of the future."
— Clifton Fadiman

Louise Brown. Now a whole clinic for test tube babies

GNAWS

The land-based answer to *Jaws* is being provided by beavers, raccoons, and squirrels, which love to masticate TV cables, telephone cables, and similar parts of technology's circulatory system. In New York City telephone company employees found 830 breaks along 15 kilometers of cable in just one neighborhood. Squirrels it seems enjoy gnawing on low-voltage lines. The phone company had to encase the cables in steel.

At the 1980 Winter Olympics held in Lake Placid, New York, ABC TV officials found that bears, raccoons and beavers were chewing on the 80 kilometers of triaxial cable strung around Whiteface Mountain. ABC put up fence around the cables. It didn't work. The network even considered skunk oil as a repellent, but technicians objected. Finally, a sonar monitor was installed so that ABC could detect and repair the cables each time they were chewed.

In Florida, a supertermite which gnaws through plaster, mortar, and various chemical coatings to get at the wood underneath has been discovered. This termite, of the genus *Coptotermes*, was found in a Broward County condominium complex. "They are bad, real bad," said one resident who found thousands of them chewing his recreation room.

The termites also have been eating through some telephone lines in Louisiana. — Stuart Diamond

The newer models of false teeth will be made fluorescent with salts of cerium (used in flints) or terbium (used in television tubes)

RADIOACTIVE TEETH

That wonderful warm glow in Grandma's smile may reveal more than inner beauty. It may be due to radioactive dentures.

Millions of Americans are wearing false teeth that have been treated with tiny quantities of uranium oxide to give them a glow that approximates that of natural teeth. Otherwise the dentures would look out of place among the real ones.

Uranium-oxide false teeth are being put on the shelf

Uranium teeth were introduced in the mid-1930s. the tiny amounts of radioactivity, judged harmless by Food and Drug Administration standards, came into wide use. In fact many if not most of the 187 million Americans who wear false teeth probably wear dentures that have been treated with uranium.

But the days of radioactive smiles appear to be numbered. Bad press in the 1970s, particularly in Great Britain, has led the American Dental Association to recommend that denture manufacturers forgo the use of uranium as they perfect nonradioactive substances. Among the new fluorescent substances are salts of cerium, used in flints, and terbium, used in lasers and television tubes. Within a year such substitutes are expected to all but replace that old nuclear glow. — Stuart Diamond

"Forget your opponents, always play against par."
— Sam Snead

CONTINUUM

AURORA WATCHING

One of the last large-scale natural phenomena yet to be satisfactorily explained is the greatest light show on Earth the brilliant Northern and Southern Lights

Physicist Arthur Wong and a team of UCLA scientists have worked out a scheme to send high frequency radio waves 40 times greater than those of commercial radio stations to measure the velocity and density of charged particles in the auroral ionosphere (between 105 and 240 kilometers above Earth)

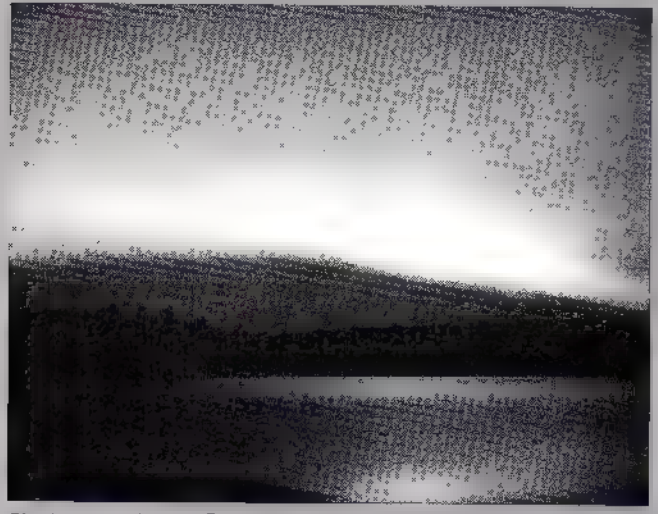
Wong says "We will have an invisible arm touching and feeling the ionosphere layer by layer at predetermined heights, which can cause electromagnetic interactions, easily tracked down by radar or seen through telescopes"

The lights get turned on, Wong says, when charged particles erupted from the sun cascade through the neutral charge of Earth's magnetic field in the auroral region But it's not known why the particles which elsewhere in space move relatively slowly become so extremely excited in the auroral region that they create spectacularly bright lights

The ground site 40 kilometers northeast of Fairbanks Alaska is being prepared so experiments can start early this year The site was chosen because of its proximity to the North Pole and to a nearby radio station complete with radar and telescope A 15-meter antenna has already been built and a two-megawatt high frequency radio transmitter is being completed at UCLA

Chief interest in the project comes from the quest for basic scientific knowledge, but Wong says the study may yield some practical applications One is to understand and attempt to diffuse the magnetic storms that often accompany auroras and that disrupt communication Another is to find a way to ward off aurora-induced currents that can flow through pipes A prime example is the Alaska pipeline which has been seriously corroded by these currents

— Caroline Rob



The Northern Lights Beautiful, mysterious but bad for the pipeline

[Science] has conquered many diseases, broken the genetic code, and even placed human beings on the moon, yet when a man of eighty is left in a room with two eighteen-year-old cocktail waitresses, nothing happens Because the real problems never change'

— Woody Allen in Side Effects

CAT SPIT

If you're allergic to cats and allergy shots don't help it may be because the fault lies, not in your pet's pelt but in its saliva Until recently it was believed that the allergen responsible for sensitivity to cats resided solely in the pelt Extracts of pelt are used to desensitize persons allergic to cats The treatment works better for some people than for others

Dr Samuel C Bukantz, chief of the division of allergy and immunology at the University of South Florida College of Medicine, in Tampa finds that some patients who are allergic to cats are more sensitive to their saliva than to their pelts Both skin tests and test-tube blood studies furnished the same results Dr Bukantz also determined that cat saliva made patients release histamine, which produces allergy symptoms

Bukantz's work confirms earlier studies by Dr Harold

Never kiss a pussycat at least not on the mouth

Baer of the U S Food and Drug Administration which show that the cat's pelt may simply be the area where allergens from other sites including the saliva are deposited

Someday, Bukantz predicts an extract of cat saliva will afford better protection than today's extracts The saliva extract would also be purer (pelt extracts usually include some blood) and easier to obtain and could be taken without sacrificing the cat

Until a saliva extract is available however it's probably a good idea for anyone who is sensitive to cats to refrain from kissing them on the mouth, anyway.

— Barbara Ford

CAPTURING BLIZZARDS

Wouldn t it be nice to capture the blizzards of January and then re ease them to coo your house come uly and August? A Princeton Univers ty phys cist has done just that

Last summer former Los Alamos bomb maker Theodore B Taylor coo ed a bu id ng on the Princeton campus by using me t water from 1 000 cub.c meters of ice made w th a ski-resort snow machine The ice was stored in a plastic lined tapered pit 20 meters on a s.de and 5 meters deep and covered over with a tarpau n

During the summer the melting cold water was pumped through the bu d ing s radiators Though the ce took just 250 hours of snow b ow ng to make it provided the same cooling as four standard residential air conditioners working through an ent re summer

When the energy books had been balanced, th s first at tempt already proved ap proximately equa n cost to tradit onal chi led water cool ng This winter Taylor and h s co leagues are consider ing ess cost y methods of making the snow and more important, better methods of conta ning and preserv ng t

This idea comes from a man who for many years was regarded as one of the fore most des gners of atomic weapons As a conceptual physicist at Los Alamos Sci ent f c Laboratory Tay or designed the largest-y eld fis- s on bomb ever exploded and also what was then the sma lest ever made For a wh e he worked on a secret government pro ect to de s gn an interplanetary rocket prope ed by 2 000 atomic bombs dropped one at a time He once smoked a cigarette he had lit w th rad at on from a bomb of h s de- s gn focused by a parabo ic m rror Stephen R Du ack

Ted Taylor (at left) with a colleague and his snow-making machine

SPELLBOUND ASTHMATICS

A San Antonio, Texas pedia trician has discovered a promising treatment for

t.on theophyll ne without exper enc ng not ceable ad verse effects Under hypno s s four ch ldren reg stered no reaction at all to an a- ergy sk n test

One asthmatic boy imag ned h mself running freely with to breath ng d ff cu ty Through self hypnos s he fulf led th s fantasy

asthma se f hypnos s n a seven-month p lot study conducted at the Uni- vers ty of Texas Hea th Sci- ence Center s x ado escents with severe asthma were tra ned by a hypnotherapist to u themse ves into a trance

To relax properly these youths would either stare at an object or con ure up a p.easing menta mage One boy pictured himse f runn ng along and breathing free y as h s ungs cleared out

After earn ng the method, a the ch.dren st ll suffered asthma attacks But the at tacks were shorter and .ess frequent and resulted in fewer emergency room vis- its A of the children stopped taking medica- t on theophyll ne without exper enc ng not ceable ad verse effects Under hypno s s four ch ldren reg stered no reaction at all to an a- ergy sk n test

They were drastica y im proved says Dr Lonnie Ze tzer who conducted the study at the school's pediat r cs department

Asthma s character zed chief y by d f cu ty n breath ing Dr Zeitzer says Bron choconstriction causes heavy mucus secretion swelling membranes, and fit- fu coughing Attacks are triggered by emot ona dis tress, a erg es strenuous exercise, or the presence of env ronmenta agents

A the adolescents per- formed wel n a follow-up test and now hypnotize themse ves about once a month The boy who v su- a.zed himself running even- tua y won a race at a track meet Robert Brody

CONTINUUM

HOT-TUB HAZARDS

The Consumer Product Safety Commission warns hot-tub aficionados against getting themselves into hot water. The agency recorded ten hot-tub drownings in 1979, all caused by excessive temperatures—including three linked with alcohol consumption.

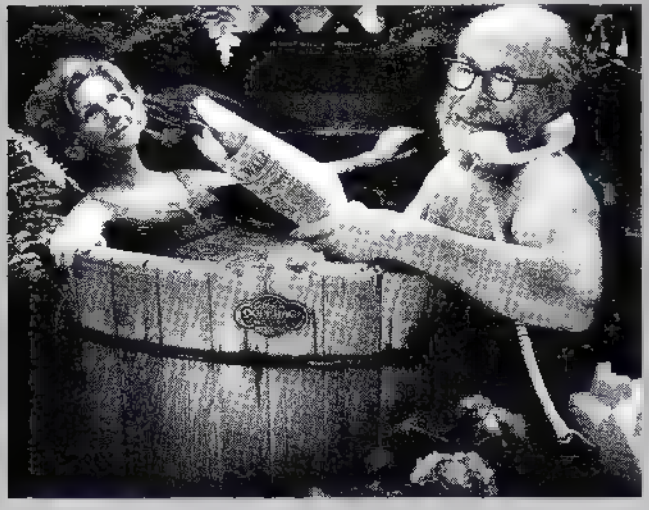
A husband and wife drowned together in a hot tub in California. Both were heavily sedated with liquor and medication for high blood pressure and heart conditions.

Most hot-tub makers post guidelines formed by the National Spa and Pool Institute. Diabetics or patients with other serious ailments are advised to consult a physician before they take a dip. Persons taking regular medication should forgo long baths in a hot tub to avoid nausea, dizziness, or fainting. Drowsiness can make a hot-tub bather pass out, slide under and drown.

Soaking in water over 41°C can also bring on heat stroke or even hyperthermia if the body fails to regulate its internal temperature.

Pregnant women or women likely to become pregnant should keep hot tub water below 40°C, says Mary Ann Sedwick Harvey, a research associate at the University of Washington Medical School.

Dr. David W. Smith, also affiliated with this school, recently studied pregnant women whose hyperthermia seemed to have caused fetal brain damage and deformation. He began the research after observing that guinea pigs were more prone, when overheated, to bear offspring with birth defects. One woman whom he examined—who suffered hyperthermia in a sauna while pregnant—bore a baby with dislocated hips, brain damage, and a nervous disorder. Robert Brody



Hot tubbing. A whole lot of fun, but keep your head above water

CANCER SLEUTH

A radioactive drug now in the works might ultimately detect most cancer cells earlier than current methods do—even, perhaps, before they develop fully into tumors.

This diagnostic sleuth may also guide doctors in monitoring metastasis (tumor growth) and in determining whether cancer patients respond to chemotherapy. Test results for two patients given the drug at Vancouver General Hospital, in Canada,

Cancers show up as dark spots

were seen as promising enough to encourage clinical trials on humans in the United States as soon as the Food and Drug Administration gives an okay. Preliminary tests on mice, rats, rabbits, and dogs have demonstrated that the drug is safe.

"It's possible this agent can detect ninety percent of all cancers," says Dr. David Crockford, of Sereno Laboratories, in Switzerland. He developed and patented the drug with Dr. Buck Rhodes, of the University of New Mexico College of Pharmacy, which is conducting experiments financed by Sereno and by Nuc-Med, Inc., and Nuclear Pharmacy, both in Albuquerque, New Mexico.

"In theory, this drug can detect tumors before there are any clinical manifestations, such as intrauterine bleeding and lumps on the breast," says Fred Mondragon, of Nuc-Med.

The theory is that most cancers in humans secrete a placental hormone called human chorionic gonadotrophin (hCG) and that when animals such as sheep are injected with hCG, they produce an hCG antibody that scientists can extract and isolate from blood samples. They "tag" or label the antibody with technetium 99—the most widely used radioactive drug—and inject the substance into the bloodstream.

Now most "tracer" drugs are targeted to reach certain organs, such as the heart or lungs, to find and pinpoint disease. But the new radioisotope latches on to the hCG that surrounds cancer cells and leaves normal cells alone. A gamma camera imaging scan records this detective work as a dark spot (the cancer) contrasted sharply against a grayish background. The most effective radioactive agents now available can detect only certain cancers, and then only about half the time. Robert Brody

"All progress is based upon a universal innate desire on the part of every organism to live beyond its income."
—Samuel Butler

FAST-FOOD BEES

The flourishing fast-food industry has produced yet another side effect— an explosion of bee populations and concern about the medical effects of more frequent beestings

Bees, it seems, love most of the food now commonly eaten on the street: hamburgers, hot dogs, steak sandwiches, ice cream, soda and beer. But this has produced an explosion in the population of yellowjackets which are really a breed of stinging wasps. Some people have been stung in the mouth while they and a wasp take a bite of the same hamburger, observes Roger A. Morse, a Cornell University professor who has been studying the insects.

Several dozen documented deaths from beestings have been recorded in recent years, but researchers fear the toll may climb. Bees are now considered in many areas the single most troublesome summer pest. A single sting can kill an extremely allergic person within half an hour, Morse said.

Scientists at Cornell have been developing a bee vaccine using venom from yellowjacket colonies. To collect the venom, the researchers put an electrically charged grid of wire under a laboratory bee nest. The wire repeatedly shocks the bees, which become angry and attack the device by stinging it. The venom drips down onto plastic sandwich wrap and is collected.

The researchers also have discovered various ways to prevent beestings besides abstention from fast foods. One is not to smell either good or bad. Both kinds of odors attract bees. Another is to jump into a nearby body of water. The bees won't follow. — Stuart Diamond

Are we facing a bee plague?

"Science is a world of most unlikely truths. And if we have found that it works, we have to thank the imaginative courage of men who were willing to fly in the face of their five senses, from the day of Galileo to Einstein."

— Jacob Bronowski

SCHMOO TREE

An almost-magical tree that can be used as a cocktail snack, a fertilizer, timber for homes, fuel for stoves, a coffee substitute, a flour surrogate, a child's candy and cattle forage has gained scientific attention as a boon for poor nations.

The tree, a relative of the mimosa, can grow 4 meters a year to a mature height of 20 meters, and to a thickness of half a meter. Its cut stumps regrow so fast that the National Academy of Sciences says it defies the woodcutter. Its scientific name is *Leucaena leucocephala*, and its disciples nickname it the schmoo after the mythical Al Capp cartoon creature that provided Li'l Abner and his friends with unlimited supplies of milk, butter, and eggs.

Leucaena leucocephala. *Almost as versatile as Li' Abner's schmoo*

A native of Mexico, the schmoo tree has not been cultivated widely. It owes its phenomenal growth to a taproot as deep as the tree is high. The root can reach nutrients and water supplies usually out of reach of other trees. Recent experiments in Hawaii, the Philippines, Australia and Haiti conclude that the tree can quickly replenish depleted forests and feed starving millions in underdeveloped countries.

The leaves can be used as protein-rich cattle feed. They are now eaten like candy by children or dipped in a pepper sauce by adults as hors d'oeuvres. One tree can produce 20,000 seeds a year. The seed pods can be eaten raw, popped like popcorn, ground into flour or coffee substitutes, made into red and brown dyes, or painted as ornaments that are then sold. The pulp can be made into paper. Bees appreciate its small white flowers.

Questions remain about its growth under intense cultivation, but scientists believe the schmoo tree holds great promise. They suggest that researchers should develop the best strains so the tree can be widely grown.

Stuart Diamond

"I am sorry to say there is too much point to the wisecrack that life is extinct on other planets because their scientists were more advanced than ours."

John F. Kennedy

CONTINUUM

NOT-SO-MIGHTY MOUSE

Ever meet a mouse with a languid libido? If you do, there's a chance its mom was a pothead.

University of Texas researchers Susan Dalterio and Andrzej Bartke fed modest amounts of tetrahydrocannabinol (THC) or cannabinol (CBN) to pregnant mice the day before they gave birth. THC and CBN are the chemicals primarily responsible for a marijuana high.

Then the nursing rodent mothers received six additional daily doses. Sixty to 80 days later, when the male offspring had attained adulthood and were tested for machismo, there wasn't a Mighty Mouse among them.

The THC-exposed young were fat and had small testes. In both the THC and CBN groups, courtship was drastically impaired. The THC mice never bothered to mount receptive females, and the CBN males lost interest in mid-ardor. Yet none were sterile.

The afflicted mice registered low levels of plasma LH (luteinizing hormone) and FSH (follicle-stimulating hormone), gonadotrophins responsible for the production of testosterone and other sex-related steroids. Even secondhand exposure to CBN and THC at sensitive periods of development appears to affect the endocrine system permanently, the study concluded.

"We don't yet know exactly how, nor do we know the implications for humans," Dr. Dalterio says. "But it's conservative to say that pregnant women should avoid marijuana." — Judith Hooper

Marijuana: Libido lessener?

GRAFENBERG SPOT

Two bold discoveries have emerged in the realm of human sexuality. Researchers have found that there's in fact more than one kind of woman's orgasm and that women can ejaculate despite the fact they have no prostate gland.

The evidence comes from John Perry and Beverley Whipple, a psychologist and nurse team of Associates in Biofeedback in Vermont and New Jersey. "We have films," they report, "of the ejaculate squirting out in response to direct stimulation of an area called the Grafenberg spot. It's located in the anterior wall of the vagina about an inch behind the pubic bone. We think it's the female prostate."

Even those great pioneers of sex research William Masters and Virginia Johnson (above), were unaware of the Grafenberg spot.

The ejaculated fluid that they've analyzed is chemically distinct from urine and vaginal lubrication. "It's most like vasectomized-male ejaculatory fluid," says Perry.

To determine when a woman is having an orgasm, Perry and Whipple use a vaginal myograph, it measures muscle tension and the forceful contractions of the pubococcygeus (PC) muscle during orgasm.

During some orgasms that is. The researchers were mystified because some women reported experiencing an orgasm when the vaginal myograph showed no significant PC muscle activity. Perry and Whipple invented a uterine myograph and added it to their recording repertoire. They found that some women experience orgasm when the uterine myograph shows activity even though the vaginal myograph doesn't, and even when no clitoral stimulation is involved. "The empirical results of our work," Whipple says, "allow us to propose that 'vulval' and 'uterine' orgasms describe the two ends of a continuum that represents the involvement of major muscles that participate in the different types of orgasm. However, most women most of the time have a combination of the two, a blended orgasm."

And the two researchers have reassuring news for some women. "Medical doctors often diagnose patients who ejaculate as having urinary stress incontinence, in that the ejaculate wets the bed. Now it seems that many women who are embarrassed to be called bed wetters actually have retrograde ejaculations into their bladders, and this creates an urgent need to urinate after sexual activity." — Bryce Britton

"If you're doing something the same way you have been doing it for ten years, the chances are you are doing it wrong."

Charles Kettering

FUSION ODYSSEY

Rockets soar on pulsing sun power while cities bask in the glow of hydrogen light as a new age emerges from the atom's core

BY MIKE EDELHART

Tilting back in my comfortable, contoured seat, I adjust the small television screen directly in front of me to obtain a better view. Through tiny earphones provided by the flight attendant, I hear the crisp, technical chatter of the crew as they ready our shuttle for liftoff. Outside my cabin window, the flat expanse of the Interplanetary Tourist Embarkation Base stretches toward the city, several kilometers away. Though it is long past midnight, lights still blaze in the city. Conservation is no longer the national bugaboo it was in my father's day. Glowing lights outline the dark, squat reason why: a fusion-power plant stationed between the spaceport and the city.

The tanklike building—a friend of mine compared it to a humpbacked tortoise—is responsible for all the casual energy use in the city and for this rocket trip, too. The shuttle is being launched at night because the power drain on the fusion plant is minimal. In a few moments all that excess power will rush toward the belly of our ship and will begin the process that is going to hurl us beyond the atmosphere.

Voices in my earphones become more imperative. Service crew members hustle about. For a moment silence, then a countdown. The video screen displays the marvelous process taking place below.

At the flick of a switch, millions of leftover kilowatts pour into a phalanx of powerful laser cannons arrayed around the base of the ship. Searing beams of light shoot forward, converging on a circle of mirrors. A computer chatters in my earphones. The mirrors move ever so slightly, focusing each violent red beam until a solid scarlet column of force shoots upward from the mirrors. The picture on my screen is so intense that everything around me assumes an eerie red glow.

Slowly the shuttle begins to lift, pushed skyward by a thick shaft of fusion-generated laser light. Within seconds the heavy hand of g force distorts my view as, from the

PAINTING BY VINCENT DI FATE

corner of my eye. I watch the earth race away from my window.

The laser glow soon vanishes. We have reached escape velocity. The pilot switches the view on my television to a forward camera, and magnificent space, lavishly strewn with stars, comes into view. In the foreground floats the spindly form of *Prometheus*, an interplanetary liner that will carry me on my long-awaited excursion through the asteroid belt.

Unlike the old fashioned chemical rockets I've inspected in the Smithsonian, *Prometheus* won't blast off in a roar of flames and then drift about in the solar system. Fusion gives our ship the steady state power to drive around space, slowing, accelerating, and maneuvering at will. Space travel no longer requires the elaborate planning that comes with aiming toward short-lived launch windows. Once my shuttle and *Prometheus* dock, I rush to my seat in eager anticipation of my first flight on a fusion-torch rocket.

Again my video screen lets me see the interplanetary vessel's launch. The camera view now comes from a small satellite many kilometers below *Prometheus*. My television screen shows the spacecraft's insect-like configuration. Far aft is the fusion rocket. It duplicates a laser fusion-power plant but with the solid container replaced by an invisible magnetic nozzle.

"Stand by," the pilot intones over the earphones. "Ignition!" On the screen vivid laser flares penetrate the explosion chamber to strike a pellet of fusion fuel. A white-hot flare saturates the screen. When the cameras adjust, the screen shows the awesome finger of sun power, like a small solar flare, blasting from the rocket's magnetic nozzle. The torch of *Prometheus* has been lit. We drive toward the stars.

Fusion power has had a most stunning impact upon life by this year 2035. My father and I often speak of it. He finds fusion's dominance almost incomprehensible, while I, in turn, find his recollections of the prefusion era quite shocking.

My father was once a miner. He's still young enough to dig coal, but for the past 20 years he has been retired on the government's fusion displacement pension plan. No one mines today. There is no reason to. Coal is probably the most worthless material on Earth, only running a close second. We don't even use oil for lubrication anymore; fusion-generated synthetic chemicals do a much better and cheaper job.

The hard times my father remembers seem very remote to me. Today life is infinitely rich in resources. Our fusion plants generate all the power we could possibly use. More important, they make it possible to create almost any material we want and get rid of anything we don't want. The virtually limitless amounts of power and heat from fusion enable chemists to create chemicals that were inconceivable when Dad was my age. If we need a new lubricant, fusion-powered factories synthesize it. If we require more steel, the fusion reclamation plants separate it out of ancient trash dumps. As a happy offshoot, our economy has become very manageable because supply and demand can be precisely controlled.

At the other end of the cycle, fusion gives us the power to atomize any material we don't need. Dad says that when he was young, chemical wastes caused serious public concern. Such wastes lay around for decades while scientists argued about ways to eliminate them. Now we just heave our wastes into the fusion torches, which break them down into simple, safe atoms.

A few decades have passed since fusion was first seen as a realistic dream in an energy parched world. In the 1970s, Dad says, scientists knew there was enough energy locked in one cubic kilometer of water to surpass all the known reserves of oil. They understood, too, that the key to releasing this energy was to make two deuterium nuclei—containing a proton and a neutron—meld together to form a helium nucleus. They had even used the process to manufacture horrendously destructive bombs. But figuring out how to control the reaction proved troublesome.

> *"Vivid laser flares bathe the hydrogen fuel in forceful light, and an awesome finger of sun power blasts from the ship's accelerator. The fusion torch is lit. We drive toward the stars."*

How, scientists wondered, could they sufficiently simulate conditions within the sun to force the positively charged nuclei to overcome their electric repulsion and combine? Obviously, scientists couldn't work with the trillions of tons of matter the sun has. Instead they would have to raise a tiny bit of deuterium to solar temperatures. This would begin the fusion reaction, which could then sustain itself. At the time many people had an image of a fusion reactor as a boiling inferno. They didn't realize that while the temperature of fusion hydrogen had to be raised beyond 350 million degrees Kelvin, the amount of matter used was so small that little actual heat was involved. A liter of deuterium—in which one proton is joined by one neutron—held in fusion reaction conditions contains only 10,000 calories of heat, barely enough to warm a cup of coffee.

Even so, achieving the temperature and pressure required for fusion took much ingenuity. The basic problem was containment. When the hydrogen neared fusion level, it achieved a form known as plasma, a gas with the electrons stripped from its atoms. If the plasma touched any other object, it would immediately give up all its heat, making fusion impossible. So some method of containing it in a vacuum chamber was seen to be essential. All sorts of magnative ideas were tried.

One approach, magnetic fusion, used various techniques to heat a cloud of fusion fuel until it became a glowing gas, then trapped the hot gas in a magnetic bottle. Scientists knew that the basic ingredients of fusion, deuterium and tritium, have a negatively charged electron circling about their positively charged central nucleus. In their natural state the atoms have no net charge and ignore magnetic fields. But when the atoms were heated until they became a glowing gas, the electrons were stripped from the nuclei. The interleaved clouds of negatively charged electrons and positively charged nuclei could then interact with magnetic fields. If the magnetic fields were shaped properly, they contained the glowing cloud of gas, increasing the chances that the rapidly moving nuclei would collide and fuse together.

In the 1970s fusion reactors were classified by the shape of their magnetic bottles. The solenoid was a cylindrical magnetic field generated by a long coil of wire. Solenoids had pinched ends to contain the plasma, but they had a tendency to leak. One solution to this leaking problem was to bend the solenoid into a circle, joining the ends and creating a doughnut-shaped magnetic field. The plasma still tended to leak out the sides, though not as badly, because the curvature was stronger on the inside than on the outside. To counteract this tendency, scientists introduced a twist to the magnetic field, so that it imitated the cords in a ring of rope. Two methods accomplished this magnetic "twisting." One was to twist the coils carrying the currents that produced the magnetic field. The other induced a current in the doughnut of plasma itself. The magnetic field from the plasma current combined with the magnetic field from the coils to produce a magnetic bottle.

A third shape for a magnetic fusion field was called the mirror machine. It used a coil wound like the seam on a baseball. The magnetic bottle it made looked like a twisted bow tie. Combinations of these basic forms were also tried: two mirrors coupled together as well as long solenoids with mirrors at the ends.

Eventually the leading candidate in the race for magnetic fusion became the Russian-invented Tokamak (an acronym signifying toroidal magnetic chamber). The Tokamak was a large fat doughnut wound with a coil of wire to create the primary ring-shaped magnetic bottle. An iron transformer core passed through the middle of the doughnut which, when activated with another coil, induced a current in the plasma that twisted the primary magnetic

field. Because of this need for a transformer the Tokamak was limited to pulsed operation. Although the "on" pulses could last many minutes, a time came when the machine had to be shut off and the transformer reset to zero so the process could start again. This necessity for pulsed operation was the Tokamak's drawback. Eventually scientists achieved a constant twist in the magnetic field while still maintaining the advantages of the Tokamak.

In inertial fusion, a second path to sunpower, the energy needed to raise the temperature of hydrogen fuel is added quickly. This reaction happened so fast that the inertia of the particles kept the fuel from expanding too quickly, allowing the fusion reaction to take place. The two primary approaches to inertial fusion used focused beams of lasers or high speed particles to implode tiny pellets of fuel. This compression produced the temperatures and densities needed for fusion to occur.

At Lawrence Livermore Laboratory, for instance, a huge multibeam laser cannon named for Shiva, the multiarmed god, concentrated kilojoules of energy onto milligram pellets of fusion fuel. In these early laser implosion experiments researchers were able to compress the deuterium gas pellets until the fuel was denser than any naturally existing form of matter. Some fusion reactions took place.

In 1978 the Princeton Plasma Physics Lab Large Torus experiment created temperatures high enough to ignite the plasma, but the plasma wasn't sufficiently dense. In 1977 the MIT Alcator A experiment created plasma densities sufficient to produce energy successfully, but the plasma wasn't nearly hot enough.

By the mid 1980s the imperfections had finally been squeezed from the fusion system. Both implosion and magnetic fusion were found to have some applicability. By the 1990s fusion had emerged from the laboratory. In that decade the first full-scale fusion test facility was built near our city.

One of my earliest memories is the day Dad and I went down to watch the engineers retrofit our local water plant to provide fuel for the fusion reactor. I was impressed and excited by the big machines and hard-hatted workers, but it wasn't until later that I understood what they were doing. The engineers were routing the city's water through a small plant that extracted all the deuterium atoms from the simpler "ordinary" hydrogen. One water molecule in every 6,500 contained the heavier deuterium which would be used to fuel the fusion reaction. From the separation plant a tiny pipe, just big enough to supply the set for a drinking fountain, carried the flow of heavy water to the reactor site. I remember my father telling me at the time that the little pipe carried enough fuel to power all the machines in the world. I was awed.

About five years later the experimental fusion station was finished. A surprisingly small squat building, it was set well apart from other surroundings and heavily shielded to prevent possible escape of high-speed neutrons. At that time the deuterium used in fusion created many high speed neutrons, which had to be handled with care. Now we use a better reaction that melds hydrogen with boron and produces no neutrons whatsoever.

Over the next few years more and more positive news came from the fusion test site. Proper temperature and pressure were achieved. Reactions that generated more power than was required to contain them became standard. Ever more energy was produced. And steadily the hardware for turning the formless energy of atoms into usable power improved.

The day of the crucial system test came when I was eleven. At noon that day the local utility was going to turn off its power plants one by one. The power would be replaced by electricity from the fusion plant. At the appointed hour all lights flicked off and moments later, flicked on again. The age of fusion power had arrived.

Once the potential of the new energy source was demonstrated it spread like lightning across the globe. Every country threw all available funds into building fusion stations. During my adolescence fusion settled in as the basic energy source on Earth. But contrary to what some early fusion advocates had hoped, it wasn't cheap. Fusion didn't wipe out energy costs. The plants were expensive and we are paying for them still. Refitting the energy production system and coping with social change also cost money.

But fusion's fuel costs were fixed. We no longer have to worry about energy expenses continually rising. Nor do we have to fear the OPEC of old. After all, what group can control a resource that is universal? Fusion will become gradually less expensive as the cost of the new power source hits every corner of the economy. When mankind recovers from the costs of converting to fusion, the price for our energy will become much lower than it is now. The basic effect of fusion is that in my father's youth things looked as if they would only get worse, but now they look as if they can only get better.

My dad gets emotional when he talks about the good life we live now. He remembers the desperation of the days before fusion, the sense that society was racing against time to develop a new energy source before fossil fuels were totally depleted. He looks back aghast at the political and emotional resistance to fusion at a time when the human race stood on the brink of extinguishing itself. Fusion, Dad says, was humankind's last best hope for surviving its own excesses. He still sometimes can't believe that we managed to successfully implement it in time.

As I look out the window of my spacecraft, watching the solar system swirl by, lifted on a pillar of solar flame, I can't imagine a different or better world. ∞

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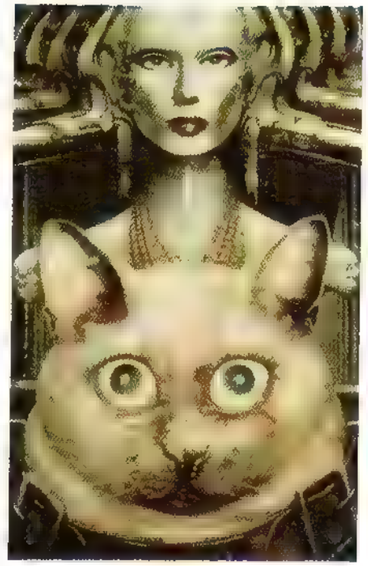

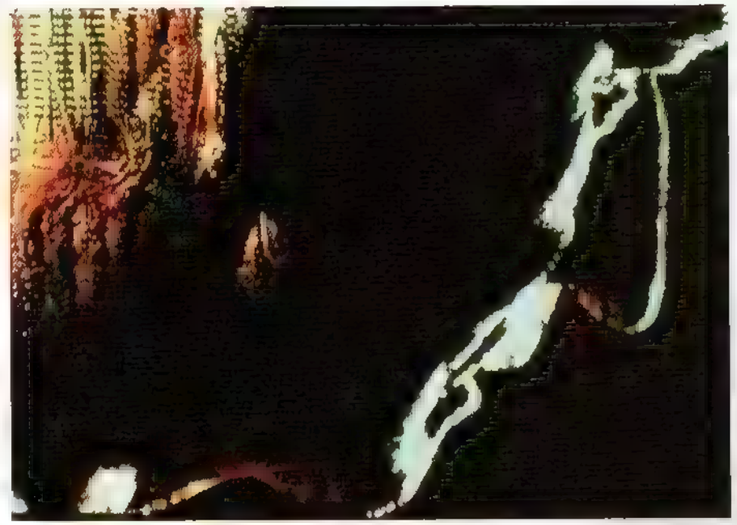

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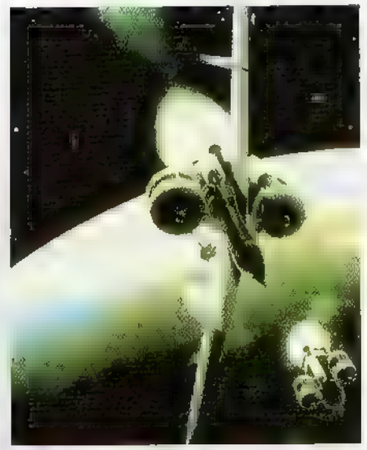

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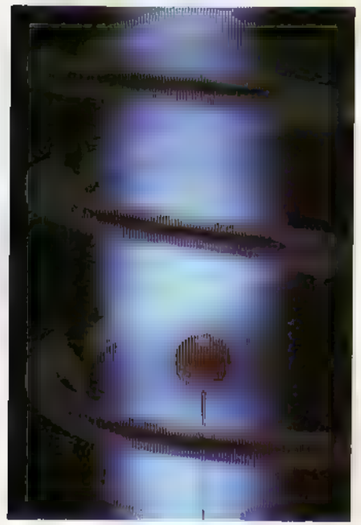
Private fusion research firms link today's theories and tomorrow's world of practical universal energy

THE BUSINESS OF FUSION



Bathed in violet laser glow a tiny plastic ball of hydrogen fuel above awaits the implosion that will begin fusion. Massive pipes surround the fat pumpkin of Doublet III, the largest privately built Tokamak fusion reactor in sight,

BY R. BRUCE McCOLM

Dr. Thiro Ohkawa of General Atomic Corporation oversees two miniature suns. The larger Doublet III is the world's largest privately built Tokamak fusion reactor. Standing inside a gigantic shed hidden away in the ravines of Torrey Pines Mesa near San Diego, it weighs 272,160 kilograms and stands some ten meters tall, swathed in 163,296 kilograms of superconducting magnets and high-energy beam generators that look like boilers that have thyroid problems.

The smaller pseudo-sun stands in Dr. Ohkawa's garage. After working a day on the government-backed magnetic giant, Ohkawa and his crew spend their nights tinkering with an entrepreneurial contraption called OHTE (from the Japanese word for "check"). It looks like an M. C. Escher birdcage, but Ohkawa says offhandedly, if it's successful, Doublet would become obsolete.

Ohkawa feels his privately funded machine could yield a commercial reactor just about four meters in diameter by 1990 at one tenth the cost of those being developed by Main Line government programs. It could be mass-produced and plugged into and out of existing power plants like a light bulb.

With an inventor's glee Ohkawa, master of the mammoth machine, explains the beauty of the small. The idea up until now has been to make fusion engineering harder and the physics easier so that we could study the fundamentals of the physics involved. But now is the time in fusion when we must make the job harder for the physicist and easier for the engineer, so that we can create power plants that are simple enough to build commercially. From an engineering standpoint, OHTE is almost like a dream.

Ohkawa represents the two sides of private fusion development in the United States today: massive megawatt systems linked to government grants and programs, balanced by tiny, idea-intensive hardware-light creations supported by private sources or a single entrepreneur's enthusiasm. Over the past ten years private investment in fusion has reached $15 million a year, a pittance when compared with the Department of Energy's $400 million annual fusion budget and the $80 billion spent by American importers last year for oil. Though dollar amounts are modest, the number of companies involved is considerable. High-tech giants like Grumman Aerospace, McDonnell Douglas and TRW are operating government fusion labs and huge Main Line experiments, small development companies, such as Mathematical Sciences Northwest and KMS Fusion, are probing new, more flexible ways of creating fusion power and tying it in to a workable commercial network.

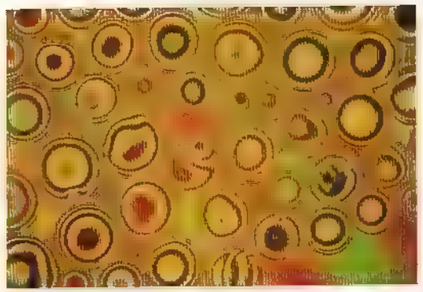
PHOTOGRAPHS BY DAN McCOY

"The fusion economy is a social, not technological, issue. Without it, we will stay low-tech, exporting wheat, importing cars"

Most fusion experts project that a mature fusion economy will develop by the year 2050. Many, in fact, believe that the successful development of fusion by then will be necessary to maintain a stable U.S. economy. Without it, our system will crumble. Dr. Dave Dingee of Battelle Pacific Northwest Laboratory in the state of Washington suggests that fusion will first enter the energy mix in about 2020 as a breeder reactor producing fuel for already existing fission-power plants. Twenty years later he speculates, the first true fusion reactors will be on line, generating nearly 15 percent of all the energy society requires.

However other experts take exception to this view. They note that the large capital costs of fusion developments — upward of $50 billion — have soured utilities on giant Tokamak reactors which will cost billions of dollars each and will last only about 30 years. Clint Ashworth, president of Pacific Gas and Electric Company, for instance, recently said that "What this country needs is to orient its fusion program more toward turning fusion into a real energy option and not just another nuclear reactor. What we don't need from fusion is a huge complicated nuclear plant with many of the same problems as the nuclear plants we already have."

William Sauber of Dow Chemical Company, who tracks fusion on



A fountain of cooling hoses sprays from the base of General Atomics Doublet III (left), a Tokamak that will generate enough power for a city, while a KMS technician views magnified laser fusion pellets (at top). Glass laser-fusion targets are coated in gold (above),

developments for the chemical industry, also objects to the knee jerk notion shared by the national laboratories that bigger fusion necessarily is better. There seems to be a Doomsday disorder that afflicts all government programs where you have an elitist group spending oceans of money and figuring on fifty years to develop a commercial reactor. The entrepreneur is thwarted because the government has sucked up all the capital from the private sector. If allowed to remain with the entrepreneurs a commercial reactor would be developed much sooner."

Though there is widespread agreement on the need to make fusion reactors as small as possible, sharp differences remain concerning just how this translates into development. Those involved in development of Main Line fusion machines believe Tokamak reactors will be the first built because they are the most thoroughly tested. Dr. Stephen Dean of Fusion Power Associates, a group of several engineering and industrial firms supporting fusion, maintains that today's seemingly massive Tokamaks won't be any larger than existing power plants when scaled up to commercial size. "Tokamaks right now are small compared with equipment used in a coal-powered plant. By the year 2000 Tokamaks will be about one third the size of today's power plant."

Don Kummer, fusion director at McDonnell Douglas, acknowledges that smaller plants are needed to phase fusion into our energy picture, but he offers the suggestion that large power plants tend to be more economical than small power plants. At a 1,000-megawatt level Tokamaks, the Elmo Bumpy Torus and other large formats will work well and will be introduced on a relatively wide scale.

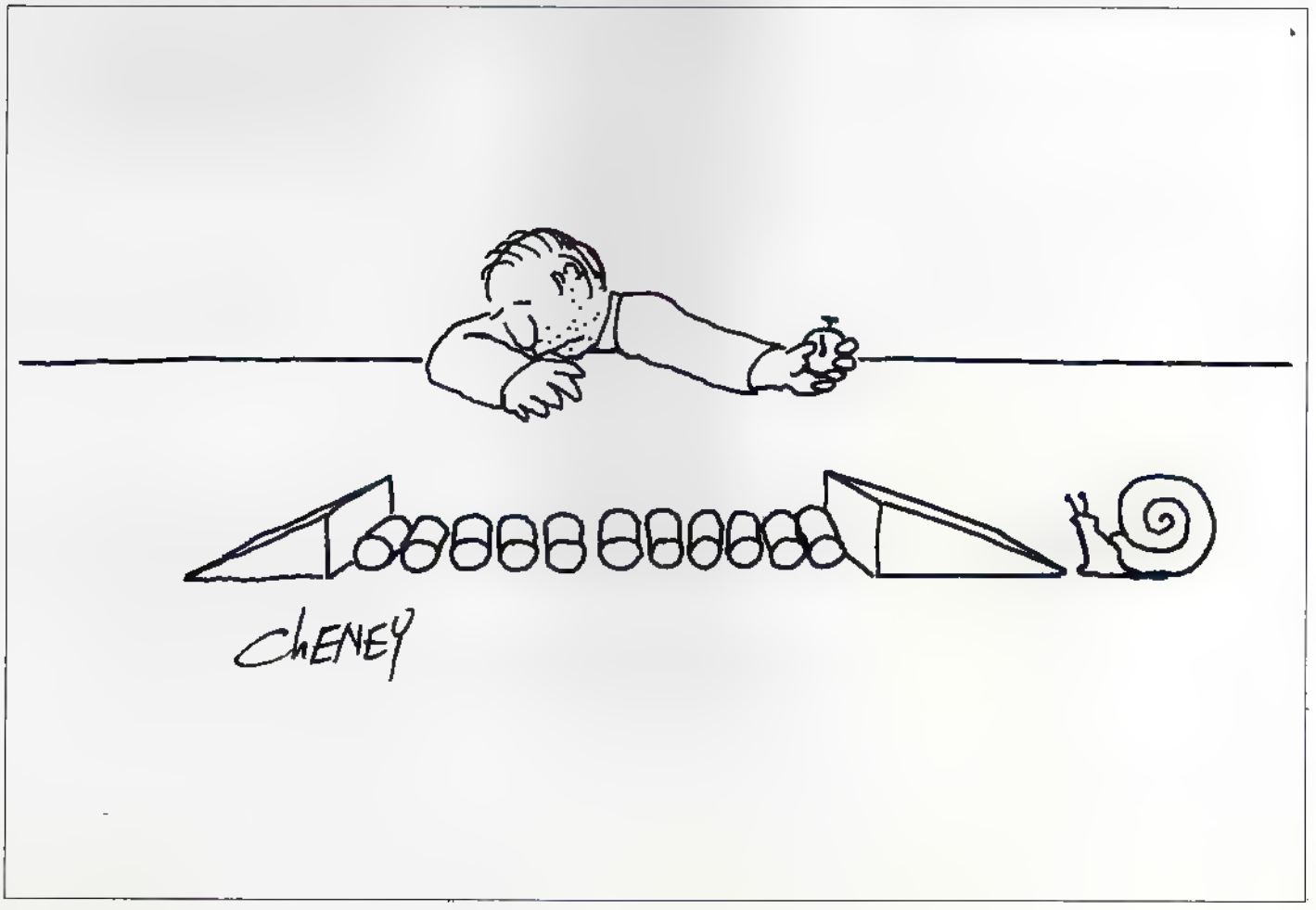
Yet the theory of throwaway Tokamaks and small fusion reactors dominates discussion among private fusionists. For them, the small fusion reactor will bring commercial reality by 1990 and wide acceptance by 2000. Radiation risks of a large plant designed to last 30 years will be eliminated. Total development costs will be just $100 million to $200 million, and the small reactor could be updated with relative ease as the technology progresses.

Perhaps the most vocal proponent of the small-is-better school of fusion is Dr. Robert Bussard [see Interview, page 56], president of International Nuclear Energy Systems Company, Inc. (Inesco) in La Jolla, California, and a former deputy director of the laser fusion program at Los Alamos. He said, "Once you start a new technology, you inevitably improve it. If the first fusion plant costs three billion dollars and has a thirty-year life, it will be obsolete before the end of its life and will not be able to compete with other technologies. With a disposable Tokamak, upgrading is easy and can be done while you're still running along."

Like General Atomics' OHTE, Dr. Bussard's Riggatron is a small, adaptable fusion reactor design. It looks like an overstuffed Slinky and weighs 9,072 kilograms. The Riggatron will achieve fusion through a technique called pop-gas fueling. Like a supercharged engine, it will be fueled with a gas after initial ignition is reached. The second thrust will create enormous temperatures and plasma densities.

Riggatrons will burn out quickly, but they can be handled much as aircraft engines now are. After so many hours they can be unplugged and either thrown away or sent back to the manufacturer for recycling. The gadget costs almost nothing. Bussard says, "You could lease them like Xerox machines. If you decided to charge them off against taxes you could throw them away."

The trials of the small-format fusion entrepreneur are exemplified by Yugoslav-born Bognan Maglich, president of Fusion Energy Corporation in Princeton, New Jersey. Unlike Bussard, who has been on the inside of fusion since its early days, Maglich has stood on the fringe of the fusion revolution. Since 1977 his fusion machine, Migma, has been idle for lack of funds. With $6 million raised from private sources, Maglich developed his controversial idea based upon the relatively unknown physics of colliding beams. In his system, positive ions are injected by a particle beam into a magnetic field where they mix with electrons and fuse. Because temperatures achieved are some 200 times those of nor-



ma fus on reactions Maglich c a ms that M gma wi be ab e to use the advanced nonrad oactive fus on fue s, such as ithium and boron Th s could produce a fus on-energy system devoid of any radioactivity

Migma consists of a cylinder 1 3 meters n diameter and 2 meters long that produces two to f ve megawatts the amount of energy needed to power an average b ock in m dtown Manhattan or an entire subur ban shopping mall Large power stations cou d be created by combin ng these 'm gmacells as Maglich ca s them For the first time, he asserts th s offers mass production n energy Ut ty companies have dreamed for years about having standard power stations Now they can have them Migmacells render high tension wires and huge power p ants obso ete and allow poorer countries to partic pate n fusion in place of a $200 mi on fusion reactor Third World countr es cou d afford a $1 m on m gmacell

The Electric Power Research Institute (EPRI) a clearinghouse of energy programs, s fund ng a TRW study to assess future uses of advanced fusion reactors Robert Scott d rector of EPR s fusion program be eves advanced fue systems wi "g ve ut ties an energy source that can be p aced n urban centers When foss fuels are exhausted electr ca ut ities will face the problem of being exc uded from ur ban s tes Since half the consumer s e ectr c ty costs come from transm ss on giv ng up those locat ons w l be an expens ve propos t on

Another smal reactor des gn s proposed by Mathematica Sciences North west Inc (MSN) of Bellevue Washington Considered by many the best sma sur vivor of the fus on program, the company has been working on aser and magnetic fus on s nce 1975 Us ng a Soviet concept reported a few years ago MSN deve oped a compact reactor design ca led Tract wh ch e minates the need for arge con nement magnets Funded at the outset by the Energy Department Tract w ll cost $100 mi on for a 7 3 × 26-meter pi ot power p ant f in tial tests prove successful a Tract plant cou d be bu t by 1990

ndustry favors sma er fusion reactors because they have more uses than the large steam-kett e methods of harnessing star power Fus on systems of every s ze can be used as fue factor es for exist ng f ss on reactors Both smal and arge designs can breed p utonium and other fis s on fuels from ow-grade ore at one tenth the cost of today s nuc ear fue Not only wou d th s uranium be cheap but t wou d a so not have to be deve oped to weapons grade reducing nuc ear fears

The advantages of sma designs center on cost and adaptab ty For example government and pr vate stud es show that small fus on plants can produce steam three times as cheap y as coa f red p ants can And the p ug n rep aceable fusion un ts some experts claim cou d be used to retrof t every power p ant n the Un ted

CONTINUED ON PAGE 86

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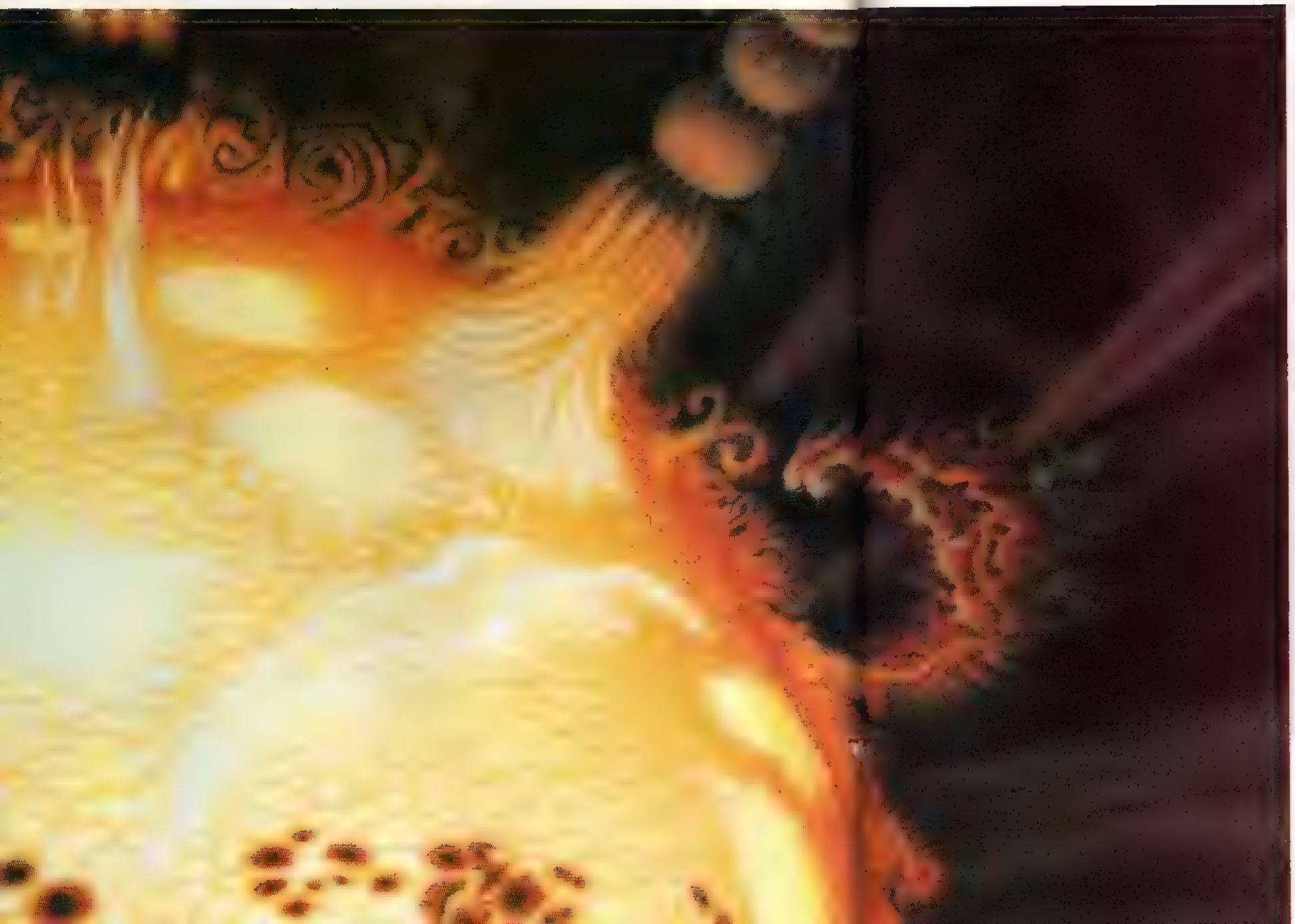

FUSION POLITICS

Science will harness the sun's power because one man whipped Congress into line

BY DANIEL S. GREENBERG

Mike McCormack ponders the questions: How did you do it? How did you get Congress to pass a billion-dollar fusion-power program on the eve of the last election? Why did federal legislators vote for an energy machine that few of them understand one that won't produce commercial electricity until at least the year 2000, if then?

"I explained to them," McCormack responds judiciously, "that fusion is the most important energy development since the controlled use of fire." He pauses a moment to let that statement sink in, then adds, "It is, you know."

Suddenly it's clear. The blocky, graying ex-chemist isn't merely the congressman from Yakima, Washington. He's a messiah in hom-mms — the messiah of fusion energy. McCormack is the reason why the United States will mount an Apollo-style effort to put fusion power on line as quickly as possible.

McCormack's achievement is even more impressive when you give it some thought. Fusion lacks the cold-blooded political appeal usually needed to open the taps of the U.S. Treasury. Practical fusion power is at least 20 years away; the politicians who sow today will be long gone by harvest time. The moon program at least offered eye-popping milestones every few months. John Glenn's solo Earth orbit in 1962, Ed White's 1965 walk in space, the climax of Neil Armstrong's moon walk in 1969. All these gave glory-seeking politicians the opportunity to posture before big TV audiences. Fusion presents no such opportunities.

Instead, its supporters are labeled as big spenders at a time when that reputation loses elections. With fusion facilities concentrated at just a few sites, congressmen can't even promise constituents a lucrative dip into the pork barrel.

And controlled fusion offers no discernible military advantages. The Soviet Union pioneered in the field, and our scientists still cooperate closely with those in the Soviet program.

PAINTING BY SHEILA ROSE

To top it off, McCormack's bill came up for a vote not long after then Energy Secretary James R. Schlesinger had scoffed at fusion research as a "scientific sandbox" and ordered his aides to chop off more than half its allocations.

With such odds to overcome, fusion's political triumph was not won easily or conventionally. It had come a long way. Though Superpower U.S.A. leaves few technological cubbies completely uncovered, some options are explored only cautiously. Until the mid-Seventies, fusion was one of the lightly covered bets. By 1968, when the overall nuclear budget was well into the billions, fusion received a mere $26.6 million—tight rations, given the high cost of research hardware.

But in April 1969 the USSR announced a major advance. Its Tokamak T-3 fusion reactor and a companion device known as the TM-3 had produced hotter, denser and longer-lasting plasma than anything previously achieved. The Russians, eager to collaborate with American scientists and engineers, openly published their findings and invited foreigners to take a look. Tokamak T-10, about three times as large as the T-3, was already under construction at a plant in Moscow.

Suddenly the U.S. fusion budget took off. It was $36 million in 1972, nearly double that by 1974—a brisk rate of growth considering the Nixon Administration's hatred of big research spending. By 1976 the fusion budget had risen nearly tenfold from the 1968 level. The Moscow Tokamak had done for American fusion what *Sputnik* had done for the space program.

In 1970 McCormack, a ten-year veteran of Washington's state Senate, was elected to Congress by an upset vote. McCormack, then forty-eight, had been a middle-level chemist at the Atomic Energy Commission's Hanford nuclear facility, and he made a prescient bid for the unofficial role of Mr. Energy.

With the space program in decline, the then-House Science and Astronautics Committee was eager to carve new frontiers. Since no one else was much interested in energy in those pre-embargo days, Representative McCormack was made chairman of the committee's new Task Force on Energy—a rare honor for a freshman congressman. Back in Washington's Fourth Congressional District, where the Hanford payroll puts the dinner on a lot of tables, McCormack's swift rise to a key energy post was noted with approval.

Though the news from Moscow had sent our fusion budget soaring, Soviet achievements couldn't keep the political heat on. Coming to power on a pledge to slash government spending, the Carter Administration couldn't see that it made much difference whether practical fusion arrived in the year 2005 or in 2025. Keep it going, they told fusion planners, but there's no need to hurry—or to pour a lot of money into it.

With a budget then over $300 million a year, fusion researchers were not worried. They could live temporarily with a stretched-out program. Research at Princeton, MIT and other American centers would soon prove the feasibility of fusion so clearly that the politicians would have to accept a speedup—or so they hoped.

But fiscal troubles were compelling the White House to squeeze ever harder on federal spending. Schlesinger, who had chaired the old Atomic Energy Commission from 1971 to 1973, believed fusion was scientifically immature—it *had been* when he dealt with it, like many others, he concluded that fusion could not stave off an energy crisis. Several key energy strategists feared that publicity about fusion's long-term wonders would breed complacency about a foreign oil cutoff. So Schlesinger put out the word: Cut $150 million to $200 million from the fusion budget.

Suddenly the fusion community was in a battle for survival. Their chosen weapon: a study by an impeccable panel of experts.

> *"Inertial confinement using lasers or particle beams might someday be used to trigger fusion weapons or simulate nuclear blasts in miniature, permitting bomb tests despite a nuclear ban."*

At that time the director of energy research at the new Department of Energy was John M. Deutch, a professor on leave from MIT. He asked John S. Foster, Jr., to head an eight-member study group that swiftly created with saving fusion from Schlesinger's ax.

Foster, vice president for energy research and development at TRW, Inc., had sterling credentials. A physicist, he had spent most of his early career in nuclear research. He had been director of the Lawrence Livermore Laboratory from 1961 to 1965, then moved on to direct research and engineering at the Pentagon, perhaps the most demanding manager's position in American research. Foster was known at TRW as a master of his profession, one of the few who could sort winners from losers early in the game, without wasting time or money through excessive caution.

The Foster Report, formally titled "Final Report of the Ad Hoc Experts Group on Fusion," covered the field. But to Washington aficionados of report literature, a peculiar and highly influential form of politicking, the essential words were on the first page. The Group believes that there is an urgent need to answer the questions concerning feasibility and that the momentum of the program developed over the past few years is a major asset and should be developed.

The go-ahead applied mainly to magnetic confinement and related technologies. Unclassified Tokamak research. The message was simple: Keep it going.

Less clear was a long passage about inertial confinement using lasers or particle beams to ignite thermonuclear burn. Most research in this area was under deep military security because it might someday be used to trigger fusion weapons. It was also rumored that inertial confinement could simulate nuclear blasts in miniature and permit clandestine weapons tests even if a full-scale nuclear test ban were passed.

Inertial confinement was considered so sensitive that most of its funding came from the Energy Department's (DOE) Defense Programs Division. When Congress's legislation went through the armed services committees. The Foster Report simply noted, "Present classification policies may impede adequate assessment" of inertial confinement and recommended periodic review of the security ratings to make certain that "no unnecessary hindrance is placed in the way of the program."

The Experts Group won the support fusion needed. Deutch, now back at MIT, says without hesitation that the Foster Report provided the basis for saving the budget.

But still another bureaucratic blowup followed close behind. This one began with a rare offer from the Office of Management and Budget (OMB)—an extra $30 million above DOE's original budget request. OMB, usually cast as a tightwad agency, said the funds could be used for fusion if DOE chose. But Deutch, along with other high-level science chiefs, rejected it. Fusion, they said, should be kept on an even keel; the money could be used for other energy research. To this day, fusion backers contend that the turndown delayed the program an extra year.

With its political flanks protected by the Foster Report, the fusion program began to yield highly encouraging results. But could it go even faster? By mid-1979 McCormack had no doubts.

A Washington veteran at this point, he set up an expert panel of his own. It reported to the Subcommittee on Energy, Research and Production, of which he was chairman, under the House Science and Technology Committee. For chairmanships—always the crucial spot in panel politics—McCormack chose a true believer, Robert L. Hirsch, Exxon's general manager for exploratory petroleum research and the former head of DOE's fusion program.

Before leaving the department, Hirsch had fought many bitter battles against budget cutters. Now he came roaring back against the timid bureaucrats who, he felt,

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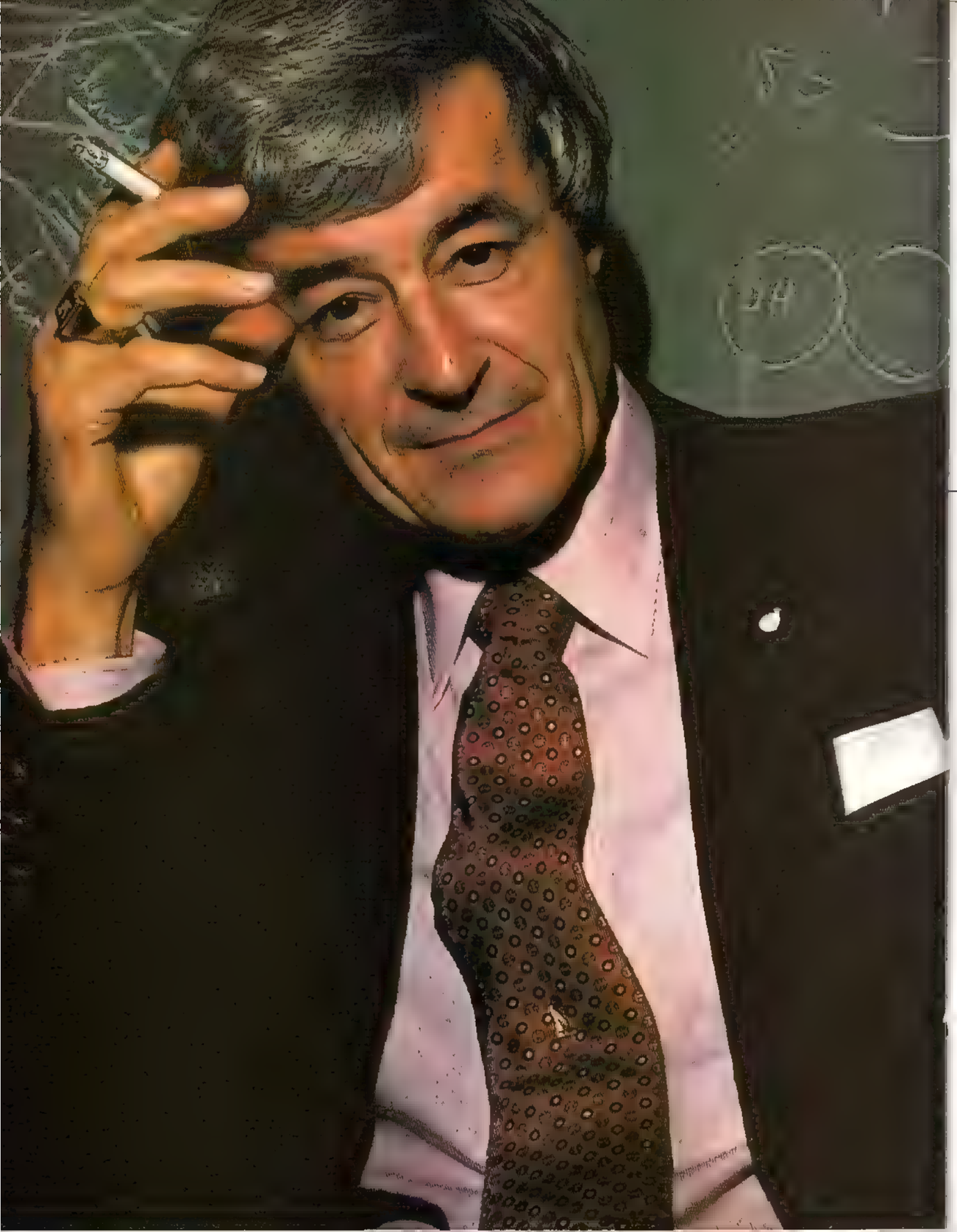

Photograph by Norman Seeff

As the most vocal and visible advocate of the small-is-better school of fusion, a former rocket engineer recalls the frustrations in trying to persuade Uncle Sam not to think big

INTERVIEW

ROBERT BUSSARD

Robert W. Bussard compares his bitter four-year battle with the federal fusion bureaucracy to a Robert Ludlum novel. It's more like the tale of David and Goliath. Bussard's small, independent company, Inesco (International Nuclear Energy Systems Company), wants to build cheap, modular, "midget" fusion reactors that could be used up and thrown away like so many light bulbs. To do it, he's had to buck a fusion "establishment" that would prefer to spend its money on large, expensive machines. Bussard compares the mammoth "Main Line" reactors being developed at Princeton, MIT, and Oak Ridge to dirigibles—interesting research devices that are unlikely ever to produce economical net fusion power. But the Department of Energy (DOE) has said that Bussard's three-foot-high Riggatron won't fly.

The "throwaway" reactor—if it does work—certainly offers a tantalizing alternative. Since it is small, it can be plugged in to existing fossil-fuel plants; its modular design can answer a wide variety of specific needs. The most important thing is it could produce commercial fusion power as much as 20 years sooner than its Main Line counterparts, saving billions in development dollars. A portable, flexible high-energy neutron source, the Riggatron is capable of producing fusion power, fission power, ethanol for cars, oil from tar sands, and nuclear fuel. In addition to all that, it could furnish estimated profits that boggle the mind: One "high-growth" model shows Riggatron-based fuel production outstripping Exxon by the year 2000.

How has this miracle technology managed to earn the enmity of fusion experts at DOE? It all began in 1977, when the Energy Research and Development Administration (ERDA) funded a $637,000 conceptual study of Bussard's Riggatron. The results, according to a DOE review panel, were discouragingly negative. Inesco protested that the panel was blatantly biased—and stacked with representatives from the Main Line labs who felt threatened by this new entry into the nuclear-fusion business. Indeed, lobbying by Main Line interests in Congress against a $7

m on appropriat ons amendment to support Riggatron research was so 'hysterical' that Representat ve Manue Lujan, Jr a New Mex co Republican was moved to spec ulate that 't was very wel orchestrated and most probab y [had] an ulterior motive "

Pressure from Congress the Office of Management and Budget and such luminaries as Edward Teller eventually did win the R ggatron a second pane rev ew But the results are hardly conc us ve The DOE s st ck ng to its previous no-go pos tion while nesco is ins sting that the concept was v nd cated We've won,' says Bussard

As a former assistant d rector of the fus on program at the Atom c Energy Commission Bussard knows his way around bu reaucratic wrangling He even ho ds a Ph D in p asma physics from, of all places Princeton Un vers ty But he kes to th nk of himse f pr marily as an engineer He was alternate div sion leader of the aser-fusion program at Los A amos and head of R&D for a div sion of Xerox Corporation Before that, he deve oped nuc ear-rocket propu sion systems for TRW Los Alamos Sc entif c Labora tory and Oak Ridge Nat onal Laboratory

Th s background above all has positioned him against what he perceives as the s ow-poke approach of the Main L ne program W th an investment so huge and expens ve the Ma n L ne fusion reactors can t afford to make m stakes Bussard, however be eves n the kind of h gh-performance eng neering that entai s tak ng chances n pushing technology to its limits They're learn ng a ot of interesting things n the Ma n Line program ' he says 'but they aren t do ng fusion They re just watching plasma part cles dance around " Dr Bussard was interviewed for *Omn* by K C Cole

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Omni: Is there real y a fus on "establish-ment" in the nat on s cap ta that excludes all but the Main Line magnetic-fusion pro-grams from getting funded?

Bussard. f you ask people in the govern-ment they would categorica y deny it ob-v ously, because to adm t t would be to agree that they are perpetrators of ev So they say 'Of course not Anyone with a good dea is welcome to come and we w be g ad to support them '

Omni But in reality?

Bussard· In real ty things are quite comp cated Everything is funded by the De partment of Energy establ shment through Germantown, Maryland which is the old AEC [Atom c Energy Commiss on] Com-b ne this with a small number of peop e who wander around the country, contending that they shou d be g ven government re-search money to fund new and novel re search solut ons for fusion In fact, one can show by known phys cs that most of these solutions don t work, wh ch is why the DOE in its reasonab e wisdom has chosen not to fund them But we did not nvent a new magical confinement scheme A we did was to take the world standard confine-ment mechanism the Tokamak and shr nk it in s ze by an engineer ng approach, not a physics approach The phys cs is per-fectly sound We don t want to f ght un-proven phys cs We never d d

Omni Then how do you explain the reac tion you got from DOE and the Ma n Line fus on people?

Bussard. The react on is simp e Suppose we're right Suppose our machines do run as a l nature tells me they will By 1984 we wi have five machines that run at power outputs of two hundred million watts for a couple of seconds Our f rst commerc al plant wi be runn ng n 1987 twenty years sooner and at one fortieth the cost of the Main Line program Now who in the na-tional program can be enthus ast c about that? The Riggatron s sw ft deve opment cou d, n the r view put careers on the line Long term personal futures are involved in this program The bureaucracy in Washing-ton, which has planned the main national program is now faced with a curiosity of a twenty-year-sooner so ution that t didn't in vent That doesn't make peop e feel good It s human nature

Omni. But the Riggatron s designed differ-ently from a standard Tokamak It s dispos-ab e or, more accurate y recyc ab e Which is it?

Bussard· You can do either You can e ther rebuild ight bulbs or buy new ones It s all a matter of cost Do you recycle your light bu bs back to the GE light-bu b factory? No You buy new ight bu bs, don t you? n this case, it is cheaper to throw the light bulb away and buy a new one We made a study that shows the cost is just about the same to make a new Riggatron from scratch as t is to recycle an o d one

Omni That sounds pretty expensive to have to plug in a new fusion reactor every fifteen or th rty days

Bussard· Is t too expensive to plug n light bu bs?

Omni But we are not talk ng about light bulbs We are ta k ng about fus on reactors

Bussard It s all a matter of look ng at power evels and the costs of the power The total energy output of Riggatron is so large and the cost of the machine so sma that when you rep ace it even if you threw the o d one away and bur ed it in a mine shaft t wou d cost you on y 1 3 mi s per k lowatt hour of electric ty that wou d have been produced by that machine

Omni And is that substant ally cheaper than what the big Tokamaks cou d pro-duce?

Bussard. Yes You can't throw away the b g machines They are ong term th rty-year-ifetime machines mu t b l on-dol ar in-vestments They are so big that the down times are nine months or thereabouts when you have to take one of these big turkeys apart and rewind it

Omni The Riggatron s so much cheaper because you avoid two very expens ve and comp cated technolog es super-conducting magnets and neutra beams Right?

Bussard: In part but that s not the main advantage Use of superconduct ng mag nets forces the overall design of the ma-ch ne to be fundamenta y different to be very arge and very expens ve You cannot put a superconductor next to the fusion plasma because the neutrons w ll over-heat the superconductor and t w ll cease to be a superconductor So you must move the superconductor behind sh elding heavy metals sta nless steel But f you do that you st have to breed tr t um for the deuterium fus on process Th s is accom-p shed by capturing neutrons n lith um But you can t put the l th um ' blanket out-s de because the sh e d keeps the neu trons from getting outside You have to put t ins de So the cho ce of superconductors requ res a des gn in wh ch you have a huge superconducting magnet f ll ng a tremen-dous vo ume of space n order to have a litt e bit of fusion p asma contained inside two meters of shie ding and a meter of l th um blanket

It a so makes the blanket an integra part of the p asma machine wh ch is a night-mare to maintain We have taken that who e geometry and nverted it put the blankets outside where they are cheap to bu d and maintain use water-coo ed copper alloys for magnets and end up with a Riggatron a thousand times smaller and four thousand t mes cheaper than a superconduct ng mach ne

Omni f they cause so many problems why do al the Ma n L ne Tokamaks use super conductors?

Bussard Because they have a nice scien-f c property Once you have current f ow-ing through them t flows forever Sc ent f-ica y that s appealing t s ke be ev ng in motherhood and believ ng that sunsh ne s good for you t is n ce if you have no osses but it doesn t pay

Omni The other ma or d fference between how the b g Tokamaks work and

Bussard How they work? Do they work?

Omni We how they are des gned to work

Bussard There s no machine that makes fus on on this p anet None To th s day no one has bu t a machine that sustains a contro ed fus on react on The on y proof that we can truly make fusion power has a ready been demonstrated by five na-t ons and those are the superpowers which have exp oded thermonuclear bombs

Omni· Do you think th s surpr ses a lot of people?

Bussard th nk a ot of peop e th nk fusion is further a ong than it s because of the way the pub c relat ons campaigns have been waged at least by the government imply ing that fusion s sort of here

Omni You've sa d that essent a y what is being done in the Main Line program is not fus on, but watch ng p asma partic es dance around What d d you mean by that?

CONTINUED ON PAGE 90

DIVINE ALCHEMIST

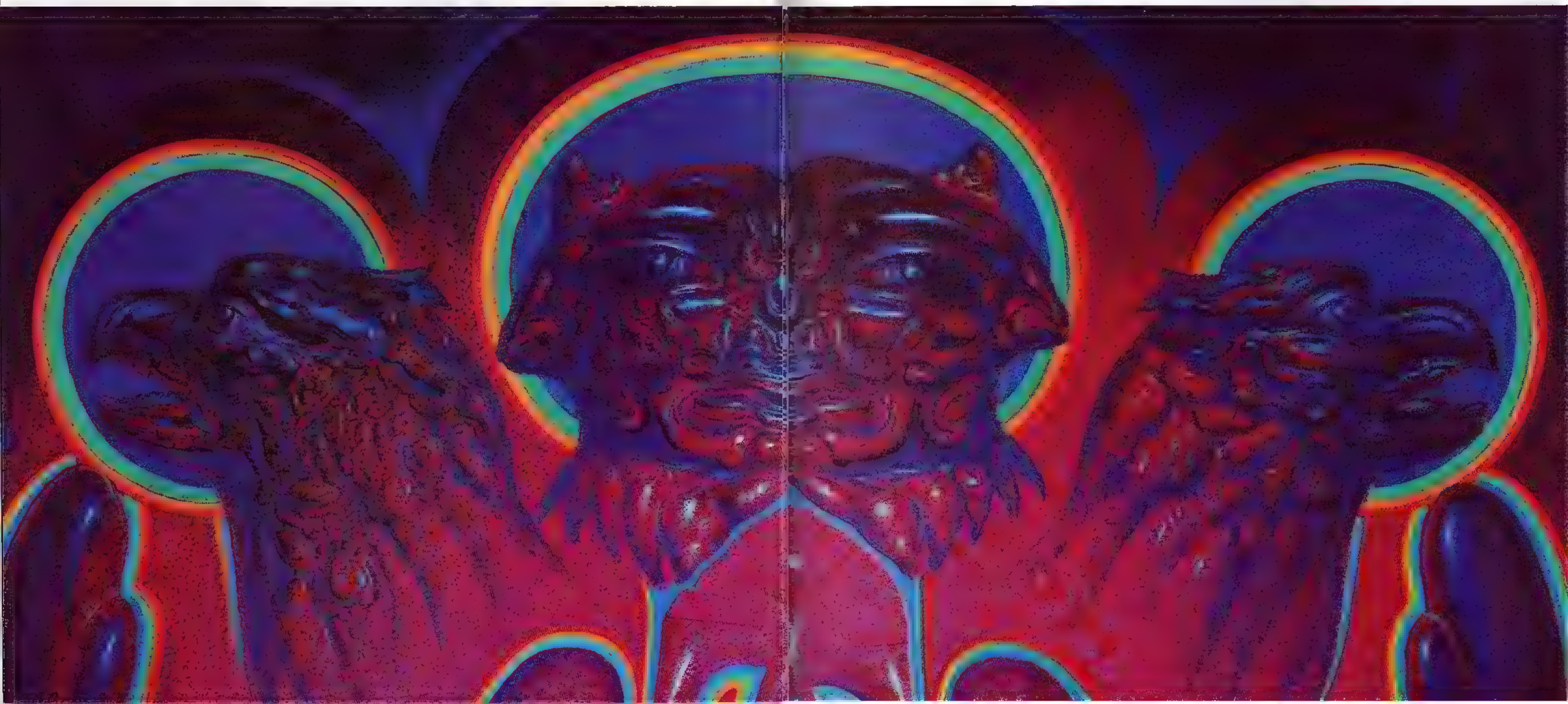
The sublime is made visible in the art of Ernst Fuchs

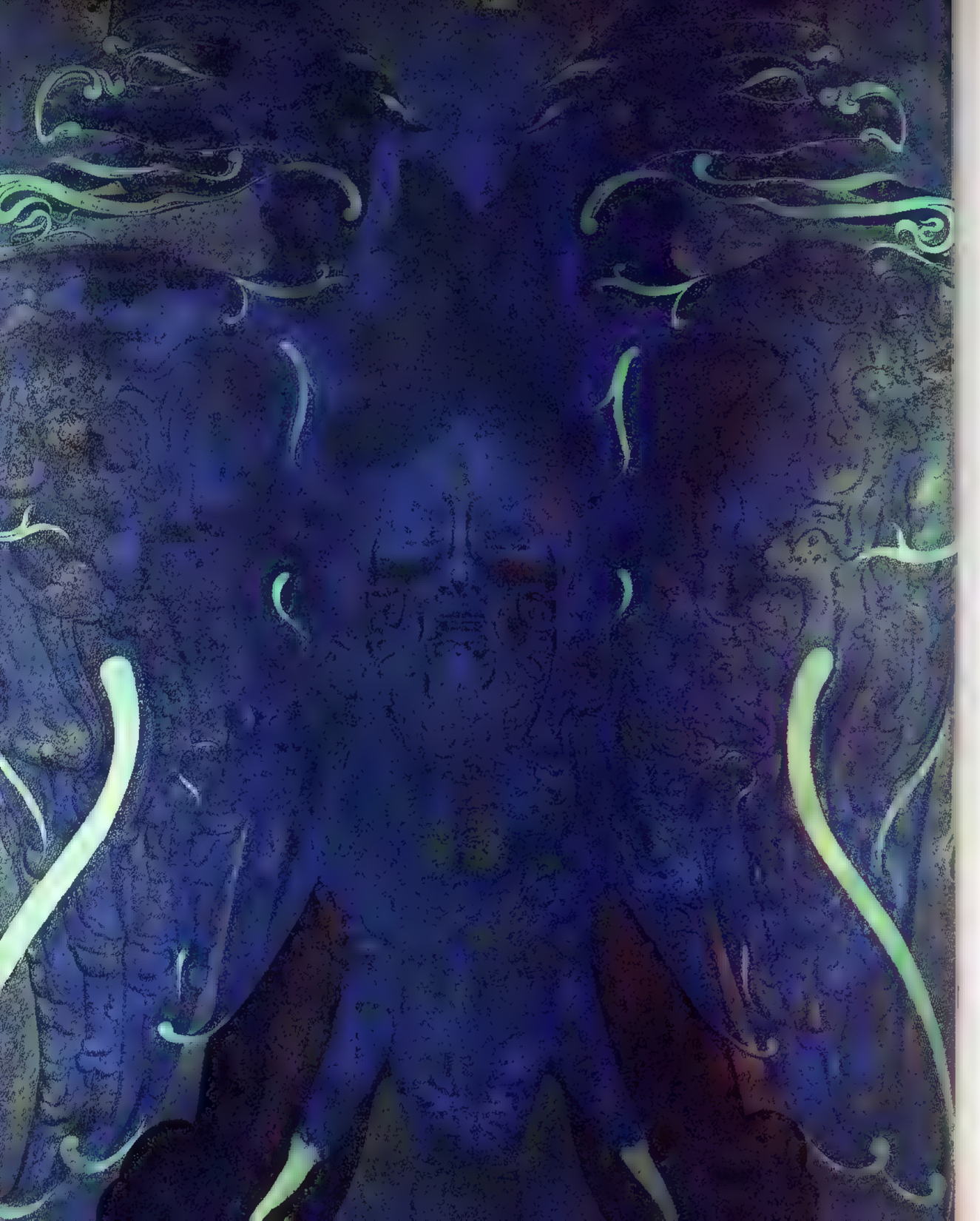
BY THOMAS WEYR

Viennese painter Ernst Fuchs inhabits the house where the future began. Built in 1888, the elegant villa is a first break with the drab imitative architecture of the nineteenth century; it marks the beginning of art nouveau in Vienna and the birth of modern architecture.

To Fuchs, artists live in the future. "They design possible future worlds. The cupolaed buildings of the Renaissance were copied from

Detail from Cherub Like an Amethyst *(below),* Cherub with Rainbow Wings *(top)*

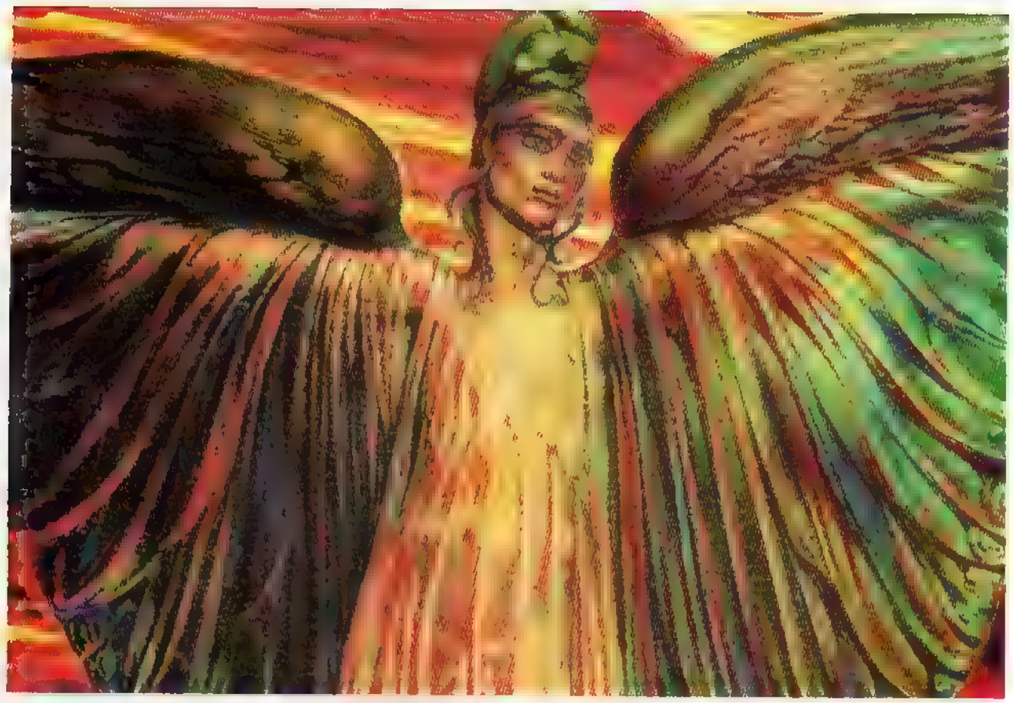




the background of Raphael's and Mantegna's paintings. The frescoes of the Baroque show man in flight, breaking the bonds of gravity, space and time. Goya and Leonardo drew flying machines.'

Fuchs thinks that some of his own apocalyptic paintings have a quality of the New Age he sees coming. It will be a mixture of romanticism, faith and exploration of the spiritual self. Like other members of the Viennese school, the artist felt early under the influence of Sigmund Freud. Whether Freud's theories

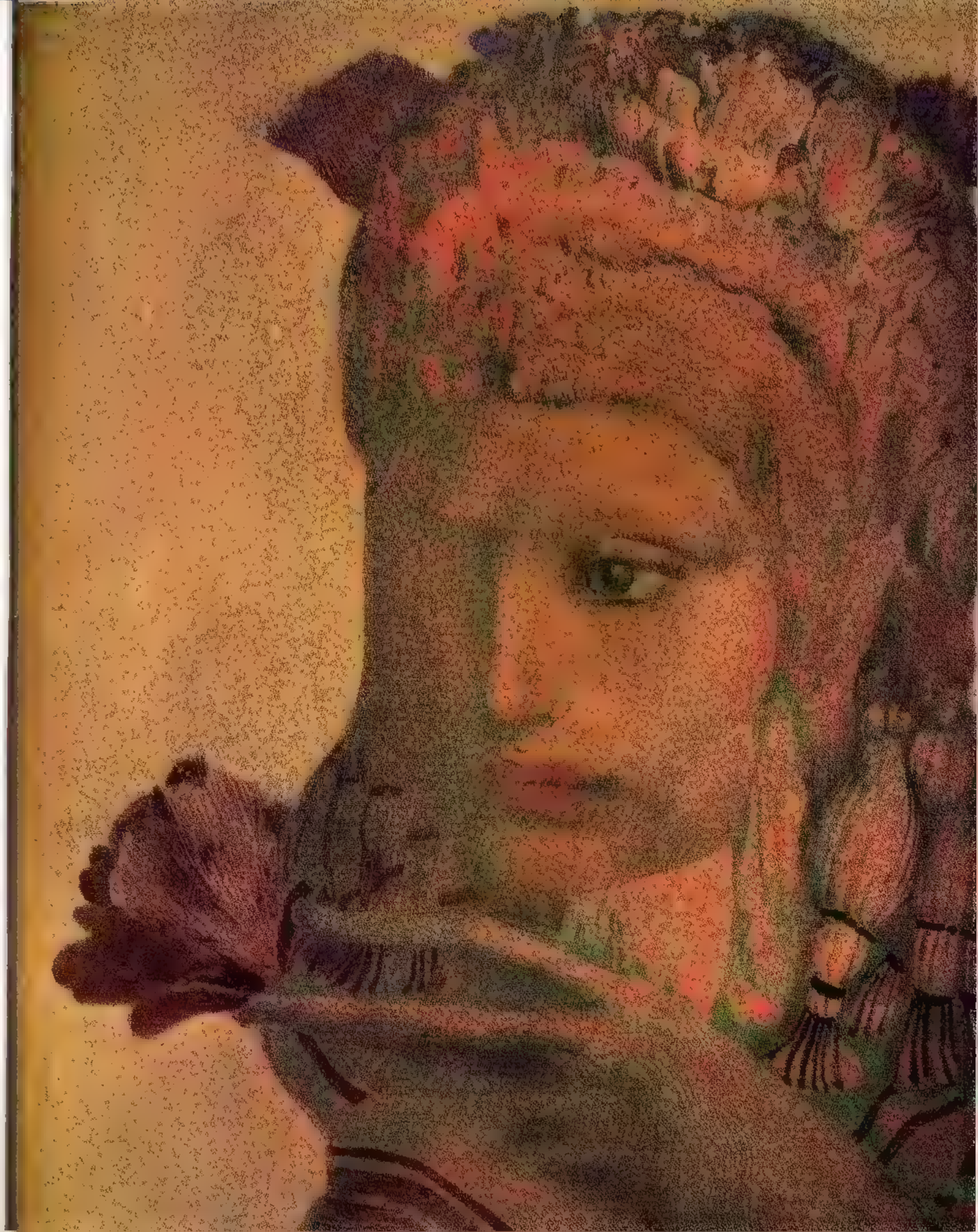
Jesus Pantocrator *(left)*, Cherub with Horns of Flame *(top right)*, and The Tree of Eden



were sc entifica. y correct or not ' Fuchs observes doesn t matter as much as his crucial d scovery that the unconscious s a d screte realm that must be made v sib e

n Fuchs s view the artistic imagination should turn to explorat on of superna. events like the sh ning cloud" that bore Christ to heaven or the mirac e of Fátima 'Art is the original manna n the desert. Fuchs says ' t alone enables everyone, even those who do not be eve to taste the true values of life We stand on the thresho d of a new era which is revealed to us through the prophetic qua ity of art '∞

Deta showing omn present cherub (above). Sphinx Ca pygos *1965 (right)*



OMNI PROFILE

Scientists are of two minds about Julian Jaynes's heretical double-brain theory of human development

PHOTOGRAPH BY MALCOLM KIRK

ODD MAN OUT

BY PHILIP HILTS

Julian Jaynes's office should be right there. The den of Princeton's outlandish theorist must lie somewhere between that classroom on my left and the laboratory to my right where a woman in white is perched on a stool. I ask, but the young lab worker doesn't know where Jaynes is. What about the door behind her stool? A closet, she says.

I stand there for a moment and then half heartedly open the closet door. A shaggy head with two bewildered eyes pokes out from behind it. They belong to Julian Jaynes, the unassuming professor who wants to rewrite most of human history. This sort of presumption inspires vicious attacks from fellow scientists. Psychologist Ronald Hayes recently asserted: "The Code of Hammurabi and large portions of the Old Testament are products of people who today would be shuffling through mental institutions. Until about thirty-five hundred years ago the entire history of human activity—including the development of language, writing, law, mathematics, and art—could be attributed to people whose thought processes would be labeled psychotic by our contemporary standards." This is the shocking hypothesis of Julian Jaynes. Shocking, indeed.

The mixture of obscurity and surprise in the location of Jaynes's office is symbolic of the man and his singular career. A shattered academic reputation and one hell of a scientific controversy lie in

the wake of this psychologist who dared suggest that modern consciousness actually evolved from an earlier two part mind. Jaynes brought modern psychological scrutiny and 20 years of meticulous research to bear on our distant ancestors. By comparing behavioral attitudes expressed in the *Iliad*, the Bible, and other works of early civilizations, the Princeton theoretician formed the basis of his remarkable hypothesis.

Until about the year 2000 B.C., Jaynes postulates, humans did not possess consciousness as we know it. In ancient artifacts and writings we notice a striking absence of introspection, of planning for the future, of putting human personal experience into narratives to clarify current thinking. These are all hallmarks of consciousness as Jaynes defines the term.

Ancient man, Jaynes surmises, lived with two minds, one dominated by the left side of the brain, the other by the right side. The former defined man as he appeared in ancient literature, a creature of everyday life. The other half, the right brain, was godlike and "spoke" to the workaday part of the mind through auditory hallucinations. These hallucinations traveled from the right side of the brain across a nerve pathway known as the anterior commissure to the left side, where the voices were "heard" as if they were coming from outside the body. Hence the steady stream of references in ancient literature to people who "hear" the voices of gods or angels and allow themselves to be guided by them. Man had a dim awareness of himself and the world, but he was directed in larger matters by the voices, much in the way present-day schizophrenics hear their own lucid conniving voices.

In other words, Jaynes believes, our ancestors were uniformly schizophrenic and were not rationally conscious. Civilization was built by creatures who did not think.

In 1977 Jaynes published his theory in a book, *The Origin of Consciousness in the Breakdown of the Bicameral Mind*. The title was intentionally abstruse, and the book jacket was plain white with no illustrations, at Jaynes's insistence. The theory was wild enough that he didn't want some wilder book jacket sending him into the Von Däniken category of crackpots. He is serious and willing to be proved wrong. If Jaynes is right, his theory will rewrite many pages of history, psychology, and linguistics. It may also suggest a future not now apparent to anyone.

A tall, thin man with unruly sandy colored hair and an oratorical voice, Jaynes bids me enter and clear a space among the heaps of papers while he makes tea. His manners are friendly and humorous.

Amazed that he managed to sell more than 50,000 hardcover copies of his forbidding looking book, the psychologist acknowledges that it is still in demand. He draws large numbers of interested, enthusiastic students to his lectures. Their professors, however, are more skeptical.

Classics scholar George Pigman, of Caltech, when asked about Jaynes's scholarship, replied, "There is no scholarship."

Carl Duncan, a psychologist at Northwestern University, was caustic. "Jaynes is extremely clever to think up this thing. I only wish he would put that cleverness to more serviceable use."

Other negative reactions are less cerebral. Soon after the publication of his book, Jaynes delivered a lecture at American University, in Washington, D.C. In the audience was Ronald Hayes, who apparently could not stomach Jaynes's speech. He grimaced, groaned, and slapped his hand to his forehead throughout the talk.

When Jaynes was finished, Hayes shot up and walked toward the door without waiting for the question-and-answer period, chomping on a cracker as he went. Jaynes was sitting on a couch as Hayes passed by, and some crumbs apparently dropped on Jaynes. Some people in the audience interpreted this as a comment that Jaynes was crackers.

Hayes says that he did not intentionally crumble crackers on Jaynes. "I have no recollection of this," he claims. "But would be happy to be that colorful. I'd be happy to dismiss him with a crumble and a crunch and then walk dignifiedly away."

Jaynes's work has drawn some positive comment from scientists, but they stop short of resounding endorsements. The bold hypothesis of the bicameral mind is an intellectual shock to the reader," Stanford University psychologist Ernest Hilgard observes, "but he is forced to entertain it as a possibility. He is asked to think about matters he has never thought about before in contexts and relationships that are strikingly new."

"A work like this is a speculative creation, an achievement that generates ideas and stimulates thinking instead of making a final statement," argues Jerome Singer, an author and a Yale University psychologist.

Jaynes insists his "bicameral man" with two chambers in his mind "can account for many things in ancient history that are not easily explained any other way. The origins and oddities of the ancient religions with their multiple and tentative gods, or the fact that all those gods are now silent, can be explained naturally, even neurologically, by Jaynes's two-part mind theory.

"Take away the voices, and unthinking people would still be capable of a great deal of normal everyday behavior," Jaynes notes. After all, we drive the highways without thinking about each of our actions and play the piano without pondering each note. "Even the most intellectual activities are largely unconscious," Jaynes reminds us, "as we know from the testimony of brilliant writers, artists, and scientists who say their ideas simply 'come to them,' popping out of the unconscious."

One of the key bits of evidence Jaynes offers is the *Iliad*, a document he says was

"When I grow up, I want to be an apologist for Arab oil interests."

written at least partly before man was fully conscious. In it we find evidence of the bicameral mind. The characters of the *Iliad* do not sit down and think out what to do, Jaynes says. They have no conscious mind as we know it, and certainly no introspection. Given our current subjectivity, it is impossible for us to appreciate what it was like. When Agamemnon, king of men, robs Achilles of his mistress, it is a god who grasps Achilles by his yellow hair and warns him not to strike Agamemnon; it is a god who rises out of the gray sea and consoles him . . . a god who leads the armies into battle, who speaks to each soldier at the turning points, who teaches Hector what he must do. It is the gods who start quarrels among men that really cause the war, and it is the gods who plan the strategy of the war. In fact, gods take the place of consciousness. The beginnings of action are not in conscious plans, reasons, and motives; they are in the actions and speeches of the gods.

Hogwash, counters Harvard psychologist Jerome Kagan. "I don't think you can use written documents like this as evidence," Kagan says. "Suppose only the work of Norman Mailer survived, and in five thousand years a scholar claims that he is going to tell about the consciousness of Western man from the way Mailer characters think. Imagine if only J.R.R. Tolkien survived. This is not adequate evidence."

Jaynes insists, though, that the bicameral period lasted about 10,000 years and didn't end until the third millennium B.C. Society was then becoming extremely complex, populations were becoming very large, and writing had begun to supplant the authority of internal voices. The godly voices at first became somewhat confused and contradictory, then finally began to grow silent. Their loss, Jaynes feels, is mourned to this day, especially by religious persons who wonder why God gave man so many miracles and apparitions in ancient times and then suddenly ceased.

Eventually humankind began to replace the lost voices with subjective, narrating, judging, introspective consciousness. The wonderful certainty of these voices gave way to the more ambiguous practices of prophecy and oracular divination, which began during this period.

Jaynes also believes that consciousness is changing in our own time and that it may be possible literally to expand the "mind-space" we have built up within ourselves. A full understanding of our bicameral heritage will enable us to teach our children how to think and perceive more powerfully.

Conservative scientists scoff. Some use John Leonard's analogy of scientists as policemen and Jaynes as a scientific criminal who must be intellectually disciplined.

Arrested with laughter, Jaynes swings around his bright blue office chair. He is delighted by the cracker crumbs story. He might appreciate the fairness of scientific police but is probably tempted to picture them as Keystone Kops.

Jaynes is amused by criticism despite what it's done to him. This closet-like space might conceivably have been a large, airy office in a better building, had Jaynes held his tongue. Still, the controversy here seems drained of its blood, shorn of its thorny spines, a passive beast that can be sent from the room by merely changing the topic of conversation. Papers, books, and letters spill into piles on the floor, competing for space with the little tribe of plants and the rusty hotplate that hold floor positions in back of his chair. Jaynes is wearing his professorial tweedy sport coat, a yellow sweater, and gray flannel pants.

Recalling the origin of his passion, he gazes pensively toward the window.

As a graduate student of psychology at Yale, the young Jaynes became fascinated with the notion of consciousness. "I decided that absolutely the only way to study the origins of consciousness was through evolution. Biological evolution had to have the answer." He began at the lowest level, plants, and attempted to find out whether one particularly long-suffering mimosa plant could learn. It couldn't. "I moved on to protozoa, delicately running paramecia in a T-maze engraved in wax on black Bakelite. If paramecia could learn, I felt, they had to be conscious." They weren't.

After other failures to find learning in the lower phyla, I moved on to species with

CONTINUED ON PAGE 87

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FICTION

It was the ultimate gamble. The stakes? His life

BODY BALL

BY JOHN KEEFAUVER

Everything seems to be in order, Mr Welling ton You may now reserve the Body Ball at your convenience "

Very good I'd like it on the seventeenth at eleven "

It's available then, sir if you care to read through the contract and sign it we can proceed for that night "

"That's not necessary As ong as the major points are the way we agreed, I'll sign "

"They re as agreed sir If you win at Body Ball, you collect one million If you lose, a your financial assets go to the syndicate, and "

"Never mind I know the second part of it very well "

"Of course sir "

"That's the only thing that concerns me, frankly—the disposal of the body "

"There s absolute y nothing to worry about on that score sir t wi be disposed of per our agreement, We stand on our record and , m sure you are aware that we have been in business ong enough to have an excellent one

We ington nodded We aware sign "

At precisely e even o c ock on the evening of the seventeenth, Wescott We ington pu ed h s Mercedes to the curb n front of one of a number of undist ngu shed row houses and turned it over to an attendant who had been waiting there As the man drove the car off We ington rang a doorbe at the house The door opened up automatically and he was ushered inside by a voice com ng from a wa speaker

"Good evening, Mr Wellington Welcome to Body Ball You may hang your coat on the rack to your right, sir, and then enter the room directly in front of you "

Wellington was surprised as he walked into the room The Body Ball machine was gigantic He'd known it would be arge, of course, but had not magined it as stretching nearly wall to wall and being ten to twelve meters wide They must have torn down almost all the wails in the house to make the room large enough for it On the other hand aside from its size, nothing about it was different from the hundreds of pinball machines he'd seen for almost as long as he could remember—nothing different on the outside, that is, the inside, of course, the part immediately below the p ay ng surface was far different deep enough to hold a body

The giant pinball mach ne was the only thing in the room except for a chair in front of t and a few steps that led up to its lower end As for the room, around the upper meter or so ran a strip of mirrored, one-way glass behind wh ch he'd been told there would be spectators, both offic a for verification and some simp y there to enjoy the show

He eased himself nto the chair s owly H s age and his paunch would be aga nst h m when he played the machine, of course but otherw se he was a healthy man Deeply tanned mpeccably dressed gray hair darkened fingers manicured, and already

PAINTING BY DI-MACCIO

feeling an anticipation, a thrill that he had thought he had lost forever he smiled when an attendant approached

"May I be of service, Mr Wellington? Something to drink?"

"No, thank you. The Body Ball is ready for my use?"

"Yes, sir. May I help you with it?"

"If you will."

Wellington got up and slowly walked to the giant pinball machine and climbed the steps down at its lower end. On the top step he bent and went through a small doorway into the machine as the attendant hurried up the stairs behind him.

Inside, still in a crouched position because of the glass above him, a pane that extended over the playing area, he edged onto a bucket seat that was attached to a wheeled scooter. The back of the seat rose to head level and was resting against the machine's giant plunger.

"Now, sir, if you will permit me."

The attendant crouched beside him now, buckled and locked the seat belt carefully, and then did the same to belts at his ankles and wrists so that, besides being made safe against being thrown from the scooter, he was unable to guide it by using his limbs outside it, although he was allowed to use all the body English he was able to muster.

"There you are, sir. All ready to go."

"Thank you."

As soon as I get out and close the door just call when you're ready and I'll send you on your way.

"Right. It will be a moment. I want to relax some first."

"Of course, sir. If I can be of more service, just give me a call. I'm here to help."

"Thank you."

As the attendant left, Wellington mused with a faint smile that it was only proper that he should be offered "service" at this time, the pinnacle of his career. God knows, he'd earned it. All of it. Service came with the good life, the rich life. The gambling life. Millions won, millions spent. He'd had it all. He'd been everywhere, done everything, bought everything. And all because of dice, cards, horses, the wheel, you name it. He'd always been a winner. Always. And he didn't have the slightest idea why. He had no system, no nothing. It was uncanny. He'd been barred from many a place through the years because of his continual winning, he'd had to disguise himself, use a phony name.

He'd resented having to do that at first, the subterfuge, but gradually he had learned to look forward to it. Because when you won almost consistently, gambling became — there was no other word for it — just plain boring. To him, anyway, and getting into the places he'd been barred from was a challenge and knocked the boredom for a while. Boredom, in fact, was his greatest problem now, and he might even have gone into some other line of work except for the style of living he'd become accustomed to, and, boring or not, gambling was his life.

When he heard of Body Ball, he was attracted immediately, thinking it impossible to be bored by the game since he could never be certain that he was going to win — in the long run, that is. One loss when playing Body Ball was the final one, there was absolutely no chance to recoup, to win. He'd be dead.

He knew the backers — casino people. They were reliable. He applied to play and, as he expected, was quickly accepted not only because they thought he had enough money to make it worth their while if he should lose but, far more important, because he was a winner and because casino owners wanted to get rid of winners legally. That was why they had invented the game, he suspected, with its extreme penalty for losing.

But why would winners play Body Ball in the face of such a penalty? Well, he didn't know what motivated the rest of them, but he knew about himself. He was here for the ultimate thrill, the greatest challenge, with absolutely no possibility of boredom. One loss ended it, if he lost, he lost his life.

He had "practiced" a joke. He hadn't even liked pinball when he was a kid. It was a game played by addicted robots — numbskulls in his opinion. And, of course, there had been no money in it. But during the last few days he had wearily played dozens of times, always winning, of course. Even so, he suspected that the correlation between playing ordinary pinball machines and playing Body Ball was infinitesimally slight, if existent at all.

Now he would find out for sure.

Taking a deep breath, he called out to the

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attendant that he was ready to start

"Very good sir"

He felt the scooter move as the plunger behind him was drawn back by a powered device. Slowly he rolled backward until the plunger was released abruptly and he was shot up an inclined corridor at stomach jolting speed.

Ahead of him rising vertically at the higher end of the machine a blinding array of colored lights began to flash spasmodically on a huge board. On the board's upper center bright green lights spelled out BODY BALL, and under the lights was a clock. Activated by the plunger's release the clock's second hand was already moving. If he stayed on the playing area four minutes (one minute for each letter in BODY) the exit slot at the lower end of the machine would automatically be closed at the end of that period of time by a device triggered by the ticking clock, and he would win his million dollars.

If on the other hand he failed to stay on the playing area four minutes and dropped through the open slot, a device triggered by his falling body promptly sealed the metal covering over the slot and him. With the covering closed and with the rest of the lower part of the machine equally sealed (the part that is into which he had fallen) cyanide pellets were dropped into acid releasing killing gas.

His speed gradually lessened as he approached the top of the playing area. Even so the speed was great enough to jolt him harshly when the scooter hit a padded obstacle shortly after he rounded the top. The scooter, which had an inflated tire-like rim, bounced back with a jerk to the top of the playing area and from here he would begin his all too speedy descent toward the exit slot at the bottom.

Just below him now were two raised parallel corridors. Hurtling backward he went through one of them, bouncing off its sides and triggering a barrage of blinding lights and a deafening cacophony of bells and buzzers on the vertical board and playing area (something he was to learn that happened every time he struck anything). Coming out of the corridor at a slight angle he crashed into a giant mushroom-shaped protrusion that with its springy edge spun him off to another mushroom and he smashed against a rectangle-shaped padded obstacle near the left side of the playing area. From here he dropped a jarring jump and he crashed into a flipper about halfway down the machine. The flipper activated on contact shot him to the far side of the machine toward the top where he crashed into another mushroom which smashed him into the bottom of one of the raised corridors.

From here he rolled straight down the center of the machine toward the exit slot, skimming past two mushrooms and not even getting close to a flipper even though he savagely yanked at the arms of the scooter with his belted wrists. He zipped past two padded obstacles, another mushroom and another flipper, gaining speed all the time. Ahead were two more raised parallel corridors directly in front of the slot, below the corridors he saw there were only two flippers that could stop him from going through the hole.

With desperate yanks of his wrists and body against the belts he was able to jerk the scooter to the left enough to smash against the top of one of the corridors which sent him back up the machine about three meters. Right back down toward one of the corridors he sped, though, zipping through it cleanly and setting off an even more horrendous barrage of lights and noise. But again using savage jerks he was able to hit the last flipper before the exit slot. It slammed him to the far side of the machine where he hit another triangle-shaped padded obstacle with such force that he thought his head would be thrown from his body. Rolling backward he crashed viciously into another mushroom. This one shot him against another tire-rimmed obstacle. Then he bounced off it and landed against another flipper which smashed him against the side of the rubber-rimmed machine with such force this time that his head crashed into the back of the scooter, stunning him. Groggily he hit a rubber-ized finger-like obstacle.

And then he was speeding down again. A flipper shot and he was moving crossways and then up once more. He was spun backward and came up heavily against a mushroom. Then he caromed off into another. Lights exploding before his eyes. Noise hammering him. Body spinning. Jerked. Thuds. Crashes. Belts into gut, wrists, ankles. Up. Down. Across. Down. Up. Across. Up.

He was near the top of the machine when the covering slowly slid over the exit slot. He had won again.

He felt the old boredom within days after he collected his million. And it wasn't long before it was unbearable again, worse, because now, having won the ultimate gamble, what was left? It was impossible for him to really win. It seemed a win freedom from boredom. *Quit? Quit gambling?* That thought itself was depressing enough to lead finally to thoughts of suicide. Gambling was his life.

Was death better than boredom? He was beginning to think so.

As he was getting ready for bed one night, he gloomily came to the conclusion that it was, and he decided to play Body Ball again — and again — and again until he must lose.

It seemed that he had no sooner got to sleep though than he woke up with a start, his boredom gone and his whole body tingling with life.

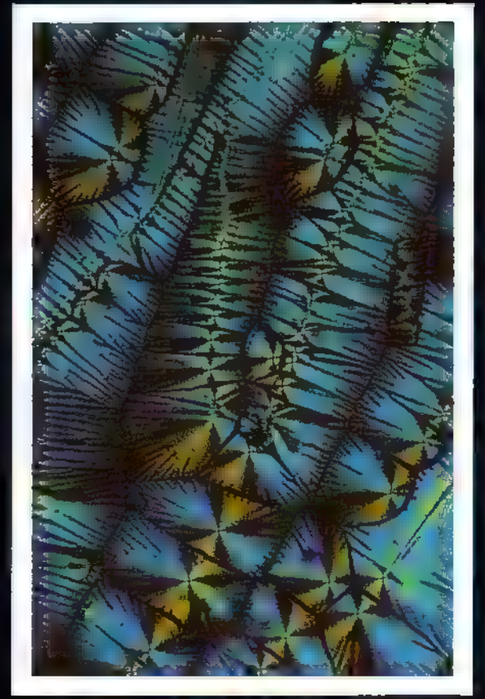
He'd bet the Body Ball owners with suitable odds, of course, that the cyanide pellets wouldn't drop into the pail of acid. How could he lose? ∞

"Even in death it commands attention."

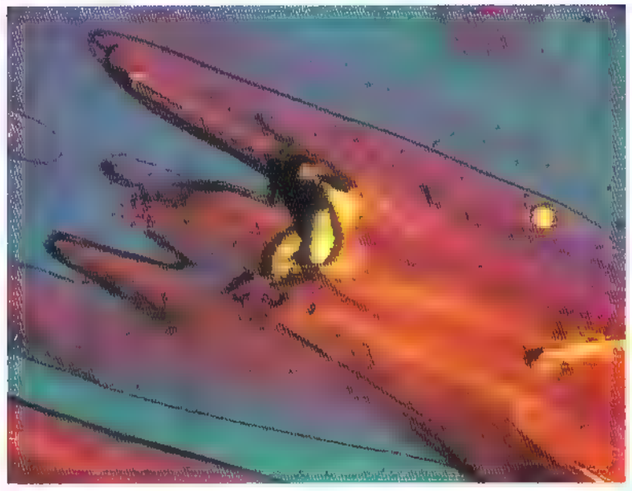
APERTURES

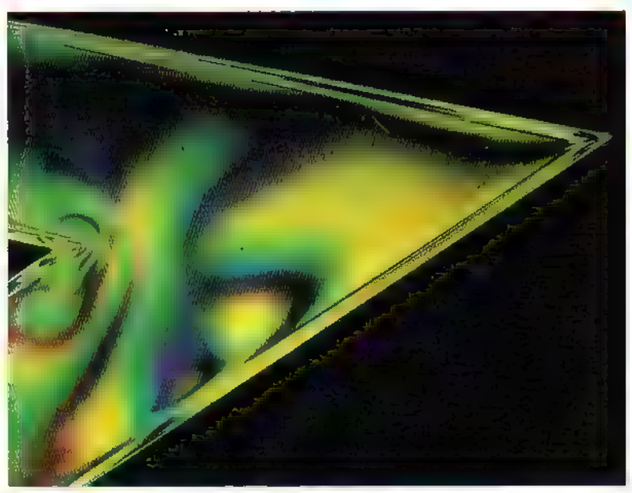
BY GEOFFREY GOLSON

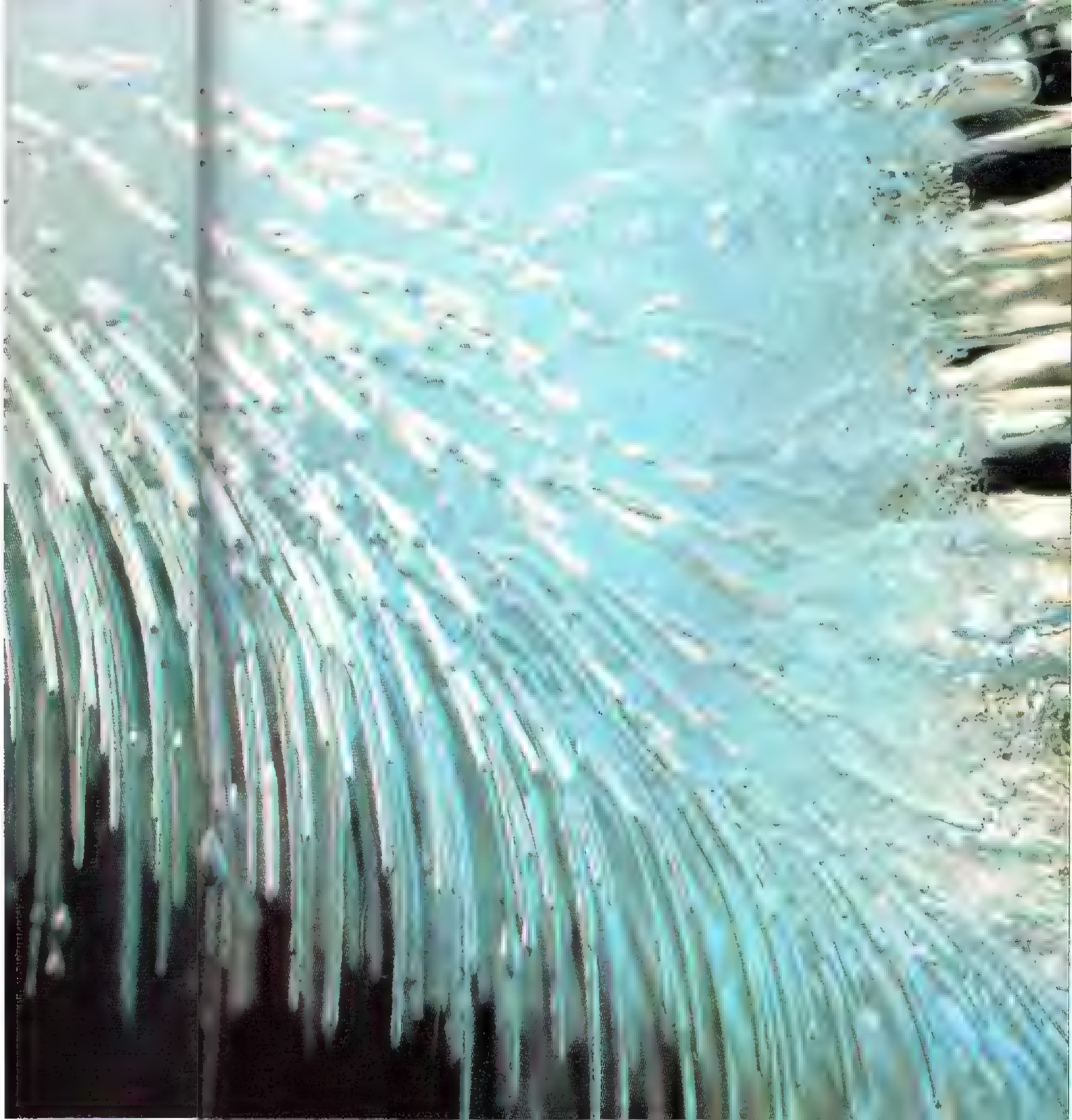
A gallery of readers' submissions to our Phenomena Photo Contest reflects prizewinning visions of the unusual. The color and brilliance of vitamin C (below) or an exploding balloon (right) portray the scope of nearly 6,000 accomplished entries from as far away as India, New Zealand, and Peru.

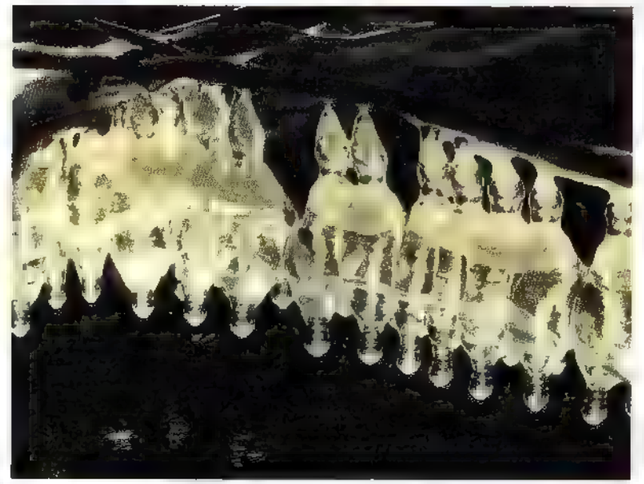


Trapped in 1/250,000th of a second, glitter dust sparkles within a popped balloon (previous page). Robert H. Miller, of Rochester, Michigan, captured this image with a Pentax ME camera while the glitter still retained the balloon's shape. Magnified by a factor of 20, recrystallized vitamin C (page 78) mirrors the cold symmetry of photomicrography. Suzanne Groet, of Upper Arlington, Ohio, matched a Hertz Ortholux microscope to a Nikon M35 and caught the startling pattern of the vitamin. A similar technique was used by Gary W. Cox, of Huntington Beach, California, to turn potassium sodium tartrate (below) into a seeping flow of colors. Giovanni Sanitate, of Detroit, cross-polarized the point of a plastic triangle until it took on rainbowlike hues (also below). Raymond E. Schenke, of Garden City Park, New York, used ordinary ice cubes to create an explosion of frozen fireworks (right). Schenke set the stage for his glacial waterfall with a black background, fluorescent and incandescent lamps. A Nikon FTN and Kodachrome 64 film recorded the image before it was lost to a quick melt.









Coral polyps metamorphose from hard, lifeless rock during the day into soft, vibrant flesh at night. While scuba diving near the British West Indies, Mike Mendenhall, of Quincy, Illinois, photographed polyps (left) exposed to a moonlit sea. Mendenhall used a Minolta 101 and macro lens encased for underwater shooting. In contrast, Erylon Hines, of San Diego, captured coral polyps as they appear by day off the Western Caroline Islands (above). At a depth of ten meters, Hines shot the closed polyps with a Nikonos camera and a 35mm lens. During an afternoon photo excursion, Anthony Armstrong, of Sudbury, Ontario, Canada, used his Pentax MX to illustrate a curious winter phenomenon (also above): icicles that assume the qualities of natural glass when they melt and refreeze. These Runners-up and Honorable Mentions were difficult to select because the quality of all submissions was superb. *Omni* readers deserve another chance to express their photographic vision. So what is our solution? See page 112 for the announcement of *Omni*'s second all-reader photography invitational. OO

PEOPLE

By Dick Teres

The 1980 Nobel Prize for physics was awarded to **James W Cronin** of the University of Chicago and **Val L Fitch** of Princeton University. You may have read of this announcement this past October in your local newspaper. Then again, if you were one of our original *Omni* readers, you would have known the identity of the winners over two years ago. We announced in October 1978, in our very first issue, that Cronin and Fitch would become laureates.

Writer William K. Stuckey in his article "Nobel Prize" that month predicted that the frontrunners for the Nobel in physics would be Arno Penzias and Robert W. Wilson. They did in fact win in 1978. Stuckey went on to say that next in line would be Steven Weinberg and the team of Cronin and Fitch. Weinberg won in 1979. And now Cronin and Fitch, who have demonstrated that subatomic particles do not always behave in a symmetrical manner, have been tapped by Stockholm.

Stuckey does not confine his predictions to science, however. On May 13, 1980, he wrote me a letter boldly picking the presidential nominees. Stuckey predicted the Republicans would nominate a President/Vice Presidential ticket of Howard Baker and Alexander Haig, who would be pitted against the Democratic duo of Fritz Mondale and Georgia Senator Sam Nunn.

Nice try, Bill. But maybe you'd best stick to the Nobel prizes.

James Cronin. We picked him two years ago.

Good news for **Ham**, the space chimp. In our November 1980 issue we reported that America's first primate in space (he was blasted into suborbital flight on February 1, 1961) was living what appeared to be an unpleasant existence at Washington D.C.'s National Zoo.

He has now been moved to the North Carolina Zoological Park, in Asheboro, a state-run zoo that specializes in rehabilitating chimps that have been raised by themselves. Ham, now 23 years old, has spent the last 17 years of his life alone in a cage. Such chimps often have problems communicating with and responding to other chimps. The plan at Asheboro is eventually to let Ham loose in a new half-acre outdoor habitat (complete with a running stream) to live with their present community of six chimpanzees.

At this writing, Ham is still being kept in a single cage, but zookeepers are putting chimps in the cage next to him so he can get used to them. Ham, according to zoo spokesperson Marcia Constantino, is doing very well so far. She describes him as "still a magnificent specimen ... and a very nice animal."

The National Zoo has officially loaned Ham to the zoological park for breeding purposes. "But our first goal," says Constantino, "is to see that Ham becomes a reactive chimpanzee again."

When computer scientist **David Hall** arrives at Stanford Research Institute International to do consulting work, his colleagues there are no longer shocked to see him wearing a skirt. Several years ago, while attending a yoga conference in India, Hall tried on a skirtlike wrap called a lungi, he's been hooked ever since.

David Hall. Mixing skirts with computers.

Hall now finds wearing trousers to be illogical, restrictive, and unintelligent. It's his goal to persuade more men to switch to skirts, especially since women now have society's sanction to wear pants.

As part of his campaign, the scientist has worked out a computer program which includes a "Boolean Truth Table" and a binary classification of all forms of clothing that he claims somehow shows the logic of his dress code. "I based my program on three basic assumptions," he says. "We are all born naked, and clothing is a form of man-made technology. Men and women have two legs, and anatomical differences (at least when it comes to skirts) are minor, and the laws of morphology can prove that when it comes to clothing there is no anatomical reason why men should wear pants only."

Dressing robots is another of Hall's concerns. "As robots become used in domestic and office situations, they'll need android-like clothing to protect them from scuffs, scratches, and dust. Skirts are by far the best design solution."

BUSINESS

CONTINUED FROM PAGE 51

States by the early twenty first century leaving fossil fuel plants as backups

But there is more Instead of wasting petroleum and coal to extract oil from tar sands small reactors can be flown to remote locations to produce needed steam

Or, what about star power under the hood? Rescon in conjunction with Litton Industries studied the possibility of using a small fusion reactor to produce ethyl alcohol from sugar cane Bypassing the need for fossil fuel the small reactor would reduce the cost of ethyl alcohol to anywhere from 33 cents to 38 cents per gallon Cane fields in Hawaii and Mexico could be converted to transforming solar-grown cane into fuel Using Litton's experience of mounting methanol plants on barges we could float small reactors to sugar fields anywhere One hundred ninety six such plants would produce enough ethyl alcohol to run every car in the United States Bussard says it would take 12 years to construct these plants at a cost of $240 million apiece "But we would have eliminated the fuel problem for cars, he notes

At KMS Fusion, not in Ann Arbor Michigan the emphasis is on laser fusion Through a system of mirrors and lenses KMS bounces a beam from a large infrared laser at a fusion fuel pellet the size of a speck of dust In 1974 KMS was the first organization in the world to produce neutrons by imploding a fuel pellet with a high power laser achieving the first laboratory scale inertial-fusion reaction

KMS Fusion has developed microminiature pellets of fusion fuel that it hopes will be mass produced for laser-fusion reactors The laser fusionists are also experimenting with various beams capable of powering a commercial reactor

A KMS subsidiary Radsyn Inc, has continued some of the company's early work on generating hydrogen and methane from fusion radiation Henry Gomberg, president of Radsyn said Fusion is almost a pure radiation source Virtually all of its energy comes out as high-speed neutrons If such a pure high intensity source is not converted into another storable form, it will be converted to heat The trick is to find processes in which radiation and heat can work symbiotically

Should Radsyn master the trick, Jules Verne's prediction in *The Mysterious Island* that "water may be the coal of the future might come true Most fusionists agree that a fusion economy would usher in an age of limitless hydrogen fuel William Escher, of Escher-Foster Technologies Inc in St Johns Michigan, asserts that, simply by generating electricity a fusion reactor could produce 453 600 kilograms of hydrogen-a day, or the fuel equivalent of 10,000 barrels of oil Even with existing technology hydrogen produced from fusion can be pumped into natural gas pipelines stored underground for the winter months and used in hydrogen-cell cars It is Escher's opinion that hydrogen stretches out the fossil fuel resources at the same time you make superior liquid fuels such as synthetic methane with the nuclear-fusion process When coal becomes expensive to extract it is economically more sensible to use nonfossil hydrogen

Besides providing an inexhaustible energy source, fusion is expected to create spinoff technologies similar to those created by the space program Offshoots of magnetic confinement research done by such companies as General Atomic in the late Fifties and early Sixties have already found uses in the marketplace Maxwell Laboratories for instance manufactures the Magneform which uses magnetic confinement to produce everything from cigarette lighters and sophisticated rockets to chainsaw handles that don't break Another spinoff is a revolutionary form of welding With high magnetic fields says Alan Kolb an eminent physicist and president of Maxwell Laboratories in San Diego we've been able to develop impact welding With this method, you can weld five to ten wall thicknesses at a shot while conventional welding deals with only one wall thickness

> *Most fusionists agree that a fusion economy would usher in an age of limitless hydrogen fuel and technological spinoffs that will spur American industry to a commercial rebirth*

In the future, fusion could turn the chemical industry upside down Using the high temperature fusion plasma chemists could take low-level carbon or hydrogen combinations — for example carbon dioxide — and forge the molecular structure desired eradicating the polluting residue of today's complex hydrocarbon processing

The implications of this, Sauber claims are that we wouldn't have pollution, but we would have vastly improved purer materials With fusion, the chemical industry would experience a total rebirth

For metallurgists concerned with the scarcity of strategic mineral resources fusion extends a promise of ecologically sound scrapyards The fusion method for recycling metals and urban waste was proposed in 1969 by William C Gough and Bernard J Eastland Their method called the fusion torch, would use the reaction's high temperature to convert metals and waste into their component elements Eliminating the high-energy input of present recycling techniques, fusion energy would allow for a far greater rate of recycling and also allow for the recycling of low grade ores now too costly to bother with

Though technically feasible the fusion torch concept has one immediately discerned drawback Energy must be expended to separate trash and pulverize it before it is fed into the high temperature plasma Stephen Dean says You won't want to feed an automobile into the reactor But hundreds of years from now we will have to use the fusion torch because we will have no other choice

Visionaries in the fusion business concur that the implications of a fusion economy go far beyond the grasp of a new method to crap aluminum caps on milk bottles A fusion economy would affect the technological base of society in general Ohkawa warned about the consequences for a fusionless United States "The development of a fusion economy is really a social not a technological issue The United States theoretically a resource-rich nation could make the choice to go toward solar and coal, while Western Europe and Japan, which don't have that luxury must take the direction of nuclear and fusion Their economies are fundamentally built on importing raw materials and adding value to their exports by using high technology When you hear people argue fusion in Japan they ask whether fusion is high technology enough Their survival depends on it If you ran this situation for fifty years Western Europe and Japan would dominate high technology The United States would remain low in technology as we are now when we export wheat and import cars Our energy situation might be alright under those circumstances but our economy wouldn't be

Other fusionists however, anticipate that a domination of the American energy mix by synthetic fuels coal and solar power would effectively close the United States off from world technological markets

The large array of Tokamaks, Elmo Bumpy Tori and Doublets on the national landscape today resembles a phalanx of weak-batteried cars trying to start up in winter The first engine that kicks over will inaugurate the Fusion Age

Then will come the challenge of commercial utilization It will present the emerging fusion industry with unique questions Can we put to our own use a power of such enormity? Can we make streetlamps from the universe's beacon? As Sauber declares "On a clear night go out and lie on your back and stare up at the sky There you see millions of successful fusion reactors Like most of our inventions and technological developments the processes found readily in nature are those most easily duplicated But instead of scaling up as we do in industry fusion means scaling down what already exists in nature

ODD MAN OUT

synaptic nervous systems flatworms earthworms fish and reptiles which could indeed earn all on the naive assumption that was chronicling the grand evolution of consciousness Ridiculous

Jaynes was so dedicated he eventually moved into the basement laboratory at Yale and set to work Embarrassed faculty members would occasionally walk in on the young scientist when he was wearing a tee shirt and had shaving cream on his face

Jaynes took many hermitages as he called them shutting out human contact while holing up somewhere to read think and do nothing else He could go on his hermitages without physically removing himself from that basement room one Yale colleague recalled He would announce that he was on a hermitage and then simply not talk to anyone not even greet them just sit in his chair and think When we asked what he was thinking of he would get a sticky smile on his face and say nothing

Even after all his work at Yale Jaynes was still confused about consciousness and began to realize that everyone else's psychology was just as confused There was no agreement on a definition Notions of awareness learning and all manner of perception were mixed into the concept

Jaynes eventually decided to strike off on his own He refused to accept the PhD for which he had finished all the requirements A ridiculous useless badge he says My brains are my credentials He simply left the country going to England where he lived on meager savings while he read thought and walked miles after mile through the hedgerows and lush pastures

As Jaynes settles into his little chair after getting a second cup of tea he tells of how the theory finally began to gel during a small cocktail party among the decks on the floor he says When I came from England to Princeton sixteen years ago everyone was still confused about the subject Socrates's flesh By trying to trace the history of the mind body dualism I traced it back and it disappeared And where it did it was in the old Babylonian priesthood in Babylonia the Pythagoreans but not in the Greek

Jaynes then started studying the words for mind in the old Psychology and mind as I hope to say but rather the actual states such as breath the terms which later came to mean emotion or mind in the old metaphysical sense Most important is the word psyche which later came to mean soul but in the old days merely meant breath

Jaynes's passbreaking breakthrough then leaps back to his chair There it suddenly occurred to me one day that the Greeks didn't have words for consciousness Maybe they were not conscious Could this be the origin of the consciousness that I'd been seeking so long in evolution? No way language experts state pointing out that the English word *mind* has no real equivalent in contemporary Italian either Not finding it in 3000 B C is less exciting when you realize it's not in present day Italian says a prominent philosopher and historian of science

The instant he made his breakthrough Jaynes knew it would be attacked but he couldn't shake his conviction that he'd found the key I knew everybody would say was insane I had a feeling of weakness even though I saw how everything clicked together I realized that the problem of consciousness had stumped so many people because it wasn't in evolution it was in human culture

Once Jaynes had put together the outlines of his theory he had to do a lot of study finding all this within the realm of the possible My mind had the same questions everyone else has it seemed impossible The pyramids built by unconscious people I'd never heard of

He'd like to experiment I could make some predictions about things in the Old Testament The older parts of the book would be bicameral that is there should be a great sense of inner words and there would be the hearing of voices The newer parts of the book would be conscious with the writers having introspections plans and so on and there should be a loss of the

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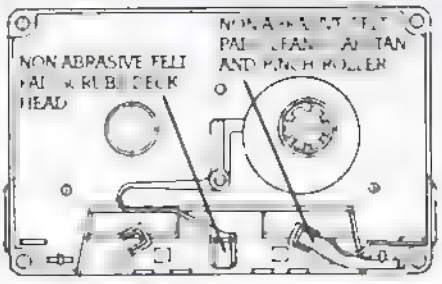

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voices of the gods. I was right.

Jaynes carried on other, more unorthodox experiments, including the time he invented a little test of right- and left hemisphere dominance that involved looking at two little cartoons and telling which face seemed happier. Jaynes designed the cartoons so that the expression varied depending on which side of the brain was dominant in perception. He cooked up the thing one midnight and was so anxious to experiment that he wandered the halls of his building looking for someone to try it on. No one else was working at midnight and so he set off for the nearest bar. He found only one drinker and the bartender. They thought I was crazy, Jaynes says, "but they went along with me. The test was successful and has since backed Jaynes's two-minded view in something over 80 percent of those tested.

A neurological experiment Jaynes has tried to get under way, but which is technically very difficult, involves testing the brain wave activity of schizophrenics at the moment they experience hallucinations. Jaynes's theory predicts that the right hemisphere should bear measurably more of the activity during hallucination. If the voices heard by hallucinating schizophrenics are generated internally in the right side of the brain and are perceived by the left side, the physical basis for Jaynes's theory will receive a tremendous boost.

Such a test might strengthen the faint praise even Jaynes's strongest admirers offer. Julian Jaynes, says a prominent psychologist, "is a serious, committed, brilliant, sensitive person, and he fell in love with ideas. Serious scholars have love affairs with ideas like this. Who knows? Maybe he's even right. Maybe there is a germ of truth in what he's saying.

If what Jaynes is saying turns out to be true, it will have an enormous impact on science, religion, and the future of the human mind. The theory destroys the foundations of religion. Beliefs unmasked as delusion or hallucination. Though the theory says nothing about the existence of God, it does blow away in a single blast all the books, idols, and rituals passed down from ancient times.

As for the mind, Jaynes believes we are in transition from the bicameral consciousness that built religion to the rational consciousness that is science. With science we must accept a degree of uncertainty about ourselves, about the world, and about knowledge; we cannot revert to desperate yearnings for holy voices, which those who embrace new cults and flock to mullahs are doing today.

Jaynes adds, though, that science itself, for all its pomp of factuality, is not unlike some of the more easily disparaged outbreaks of pseudoreligion. In this period of transition from its religious foundation, science often shares with a hundred other irrationalisms the nostalgia for the Final Answer, the One Truth, the Single Cause. In the frustrations and sweat of laboratories, science feels the same temptations to swarm into sects. And all my work is a part of the transitional period after the breakdown of the bicameral mind.

As Jaynes gets up to go to a faculty party, it is nearly sunset. Though he does join with the faculty in events at the university, Jaynes is virtually not a part of it anymore. From the rank of assistant professor not far from tenure, he has now been demoted to part-time lecturer with a salary of $4,000 a year, less than a graduate student makes.

Whether he is a prophet or not, Jaynes is certainly without honor among the academics at Princeton. But however successful Jaynes and his controversial theory end up, he has at least accomplished one core task that he set out to do. Jaynes once said that psychology as a science should not ape physics in its mathematics or its certainties. Physical discoveries may be called breakthroughs, he said, but psychology's corrective verb should be *break out*. Whenever some mode of thinking or some theory throws a net around the thinking of psychologists, the time will come when that "envelope" is suddenly seen to be a subjective barrier, a part of the psychodynamics of the scientist himself.

From traditional psychology, from rat labs and blind mazes, from the quicksand of verbiage about consciousness, Julian Jaynes has broken out. ∞

"I'm afraid you're not qualified to join. You don't have enough worldly goods to renounce."

INTERVIEW

CONTINUED FROM PAGE 58

Bussard Generally the national fusion program is dominated by considerations of understanding plasma physics not to be confused with building devices to control fusion. The national fusion program which is now running at 1.8 million dollars a day and would like to spend more is doing beautiful research on the nature of plasmas their confinement their instability and their transport across magnetic fields. We need that. We rely on some of that for basic information. But the national program is really not an R and D program. There is no D.

Omni You mean they want to know a lot of the physics thoroughly before they try anything?

Bussard You hit it right on the head. And that's almost the only thing they can do because the large machines they're evaluating as future power systems are gigantic and cost several billion dollars each. Before you are willing to commit several billion dollars on one machine you had better know everything in the world about it absolutely everything. Our machines are hand made versions built in small machine shops. At most they will cost about a million to a million and a half dollars each. Not billions millions. We plan to build five of them simultaneously of slightly different configurations shapes, fields materials and find out which ones work best why and how and which ones fail.

Omni That seems ironic. The national program is trying to save money by being cautious when in truth

Bussard They are saving in respect to the program they are doing. If you went and built five two billion-dollar machines and ran three of them to destruction you would have blown away six billion dollars which isn't wise.

With our approach we shall be able to test whether Tokamaks work or not in a fusion mode before anyone else can at very low cost. If for some reason unknown to us a new physics problem appears we will learn it sooner than anyone else at modest cost. We may even find that Tokamaks don't work - in which case all Tokamaks don't work. In that case most of the world fusion programs are going to be in deep trouble.

Omni Let's go back to how Riggatrons are different. Another expensive technology that you avoid is neutral beam injection. How can you get to high enough temperatures with ohmic heating alone?

Bussard It's like heating a toaster wire. Fusion will begin to occur if a current is simply passed through the plasma. It requires a certain set of conditions for the plasma density. If the plasma density is too low, putting the current through it will not work successfully. If the plasma density is too high it is going to require much too much current. There is a range in between those two in which the density is just right. To find out what those conditions were that was the burden of our calculations in 1977. And that was the basic thing that my colleague Dr. Bruno Coppi at MIT who is the coinventor of this concept learned that it was possible to reach ignition by ohmic heating alone, without any neutral beams without any microwaves just through resistance in heating the plasma.

Omni Why didn't anyone else think of that?

Bussard Well they did a long time ago furnishing the basis of the world fusion program. Then they abandoned it all and went back to studying basic physics. But physicists don't think about nor do they understand power engineering and are not abreast of current developments and materials that come from other fields. They seized on superconductors as wonders of science and the whole program has gone off in that direction. We took a different approach and said: Let's look at what the aerospace world brings to us because I am an aerospace engineer by background. That's where I began.

> *"With our approach, we will be able to test whether fusion actually works or not before anyone else can. If we find it doesn't work, the world's fusion programs will be in deep, deep trouble."*

Omni In other words when the DOE review panel said you were pushing technology beyond the state of the art it didn't know what the state of the art was?

Bussard The panelists didn't have any idea what the state of the art was. If you look at their backgrounds almost without exception they have never built anything of any kind at any time.

Omni Didn't they say for example that the first wall in your Tokamak would melt?

Bussard That was nonsense. Total nonsense. It was said by people who have no experience in building heat transfer systems that conduct high heat flows. The kindest thing that you can say about those on the first panel is that they were woefully ignorant of the engineering technology of high power machinery. That is the kindest thing. For the second review we had an honest unbiased, and non bought and paid-for reviewer in the form of a gentleman from NASA Ames. This man has built a high temperature water cooled, constricted arc with the Ames Aerothermodynamic heating test facility for the shuttle. It's a tremendous machine. It has run three years without a failure. The heat fluxes that he can take on that arc on the first wall are three times the highest heat fluxes that we have ever seen required for any version of Riggatron reactors. And he sat on the panel and said that heat transfer is no problem.

Omni. Then can we review basically what happened? You received more than six hundred thirty seven thousand dollars from ERDA for a conceptual study after which it was downhill all the way.

Bussard. No it was uphill. It was progress as far as we were concerned. For the first time we had money to explore the engineering parameters that bounded the physics requirements. As a result of that study I was a hundred percent confident it would work.

Omni. But something happened.

Bussard Yes it did. The scientific community aligned itself against us. In the spring of 1978 a board was convened to evaluate Riggatron's feasibility. The panel met and produced a report. The report was so asinine that I wrote a twenty page rebuttal. The rebuttal got the panel to reconvene and consider it again. They came out with essentially the same kind of idiotic statements. Then they went downtown to higher levels of DOE and made presentations condemning the Riggatron concept. The Office of Management and Budget was brought in to hear those presentations ostensibly to get them to say this was a bad idea. The OMB got so troubled and unhappy it called me right away and said, "What the hell's going on? We hear this thing won't work that the machine will break. It was the first I'd heard of such a meeting.

Eventually OMB called its own meeting of OER [Office of Energy Research] OFE [Office of Fusion Energy] and OMB. And OMB went away completely with a mind that the entire DOE review report was discredited. Totally and fairly discredited.

Omni Was this the meeting that someone described as a shootout?

Bussard. Yes. We utterly destroyed them technically. We were right and they were wrong. Congressman Mike McCormack [of Washington] asked the people at DOE to arrange another review committee from outside of the system. The second group was headed by honest guys with track records of some stature. Their report showed conclusively by all known physics that the machine will ignite.

Omni What was DOE's reaction to this second panel review?

Bussard They wanted devoutly to ignore it. The Office of Energy Research finally came out with a report around the end of November 1979. If you read the body of the report and the technical analysis you will find that it says what I said earlier. But it has a one-page executive summary dictated largely as a cautionary note to upper management at DOE. It says in effect: We think it's high-risk and it may work and it may not but in any event it should be viewed in the context of the larger program. Meaningless. So now they can ignore it. The report was never distributed. You don't want to distribute a

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–Stevie Wonder–

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report like that right? You want to distribute only the executive summary. So they did.

Omni Could one problem with acceptance of the Riggatron fusion reactor be that it goes totally against the long-life thinking that goes on in the utilities industry?

Bussard It doesn't go against it as if we took a ninety degree turn in the road and said there's another way around a certain mountain. You don't have to climb straight over it, you can go around the other side.

Omni You've said that the utilities don't like the large Tokamak approach either because they are too complex and too expensive. The Riggatron is appealing because it's modular and replaceable. How does that work?

Bussard Think of a string of light bulbs. You want to have five lights burning at all times. You build a string seven bulbs long and you light five of them. When one burns out you turn on the sixth and you have no down time and replace the burned out bulb.

Omni So you can make power for utilities. What else can Riggatron do?

Bussard That's tied to do with producing cheap steam. The Riggatron is really nothing but a steam generator. When you compare the cost of steam from natural gas fired plants or coal fired plants, this thing produces steam at one-third the cost. So we make such steam, and with a gadget that's so small it can be shipped in an airplane to the tar sands region. Then we pipe steam at three hundred fifteen degrees centigrade down one hundred eighty three meters to tar sand formation and steam oil out the tar sand and get oil.

Omni And this and you make ethanol too.

Bussard That's a different use of the same cheap steam. It's just the fact that the steam is so cheap and comes from an inexhaustible source.

I can also tell you about breeding nuclear fuel. The world's breeding reactors whether we are or not. There are hundreds of them overseas, they are being built in France like potato chips. All we need nuclear fuel. Riggatrons are probably the world's best breeders of commercial-grade fuel. It's completely proliferation proof fuel. You can't make a bomb out of it because it's isotopically all mixed up. And there's an infinite supply so long as you have thorium and there is twice as much thorium as there is uranium 238.

And last but not least because this such a copious neutron producer. Riggatron light bulbs can take fission waste products from reactors or from hybrid blankets and put fission waste product blankets around the machine. Then by neutron transmutation you can burn up the wastes so that they no longer constitute a nuclear waste-storage problem.

Omni Is this how you come up with these incredible profit projections?

Bussard The profit figures come from almost anything this machine can be applied to. It turns out to be the same incredible profit margin because the energy cost for any of them is so small.

Omni And what exactly are those projected profits?

Bussard It depends on how you capitalize it. If you use thirty percent equity capital investment and seventy percent borrowed capital you can generally show a case for an eighty to one hundred twenty percent return on investment. Only if you're in a totally free economy of course.

Omni That's certainly a very profitable business. So why did you need government involvement in the first place?

Bussard I simply wanted to get one government contract which has one very great virtue associated with it. It means that our Tokamak was at least of sufficient interest that the government would look at it and say, "Hey that's interesting. Let's put our USDA prime beef stamp on it because we'll fund a study."

Omni Then why did you go through this big battle if government approval wasn't all that important?

Bussard Because the government produced a report that was technically false which was made available as a public document. I went to some government officials to make them do an honest assessment on paper admitting what they had done. That's all. I don't like being lied about.

Omni Since you're in this for profit, why should the government be supporting your research?

Bussard I'm in this for a lot of reasons other than profit. It's a damned shame that the United States is not solving the energy problem. The U.S. government alleges that its interests lie in solving the energy problem. As far as I can see, those are empty words. The government's interest is in doing research on long-term solutions not in grappling with real solutions for today. The technologies that could be brought to bear now such as the Riggatron and other things in energy development are not being promoted by the government.

Omni Had you stayed at the AEC would you have been able to convert the federal fusion program to Riggatrons?

Bussard I've no doubt that the AEC would have picked it up and run with it. I believe that sooner or later the government will be driven to it. Let me add that it is being done now. Independent of us and the Energy Department. The Soviet Union is busily constructing a Riggatron-like device.

Omni What's their name for it?

Bussard It's called the T-200. The Russians are certainly going to build these machines as the best vehicles for fusion. They're also going to build them in order to produce massive quantities of plutonium for the Soviet plutonium reactor economy, and they have said they will do so by the early 1990s.

If our current program is successful we should beat them to it by five to seven years, recapture the world energy market from the OPEC cartel, and provide cheap energy across the board for the next several centuries, at least. ∞

FICTION

A CAGE FOR DEATH

Born of Hewitson's obsession, the machine was built to vanquish mankind's greatest foe

BY IAN WATSON

Ralph Hewitson's Thanatoscope was the ultimate product of that strange man's obsession with death. Thanatology is, of course, the study of dying, and Hewitson's machine was intended to enable us to see, and ideally to "trap," Death itself. Or himself. Ralph Hewitson always took it very personally that he or anyone else should have to die.

No doubt all of us go through this stage of horror and affront when we are children. Then we file the trauma away in the back of our mind. We lock it up in the mental lumber room, and it creeps out again only in our last days. Sometimes it remains as offensive as ever, but increasingly nowadays, thanks to the Thanatology Foundation's centers across the land and the reinterpretation of dying as an altered state of consciousness, it is transfigured into a friend, an intrinsic part of oneself, the keystone of the arch of life.

Hewitson, however, kept intact the old animist vision of some invisible thief of life. His Thanatoscope, his death-watch device, was to be the tripwire camera, *and cage*, that surprised Death himself.

True, some scientific testing of death has been conducted in the centers, in addition to the psychological studies and therapies, but only in the sense of weighing the body before and after death to see whether any tiny weight loss occurs, as of a departing soul, or using aura photography to try to record this departure on film. None of these fringe investigators have ever tried to demonstrate the converse occurrence, the *arrival* of Death as an active force.

Hewitson was a tall, black-haired man with a slight permanent stoop, as if he never trusted doorways to be quite high enough to let him through.

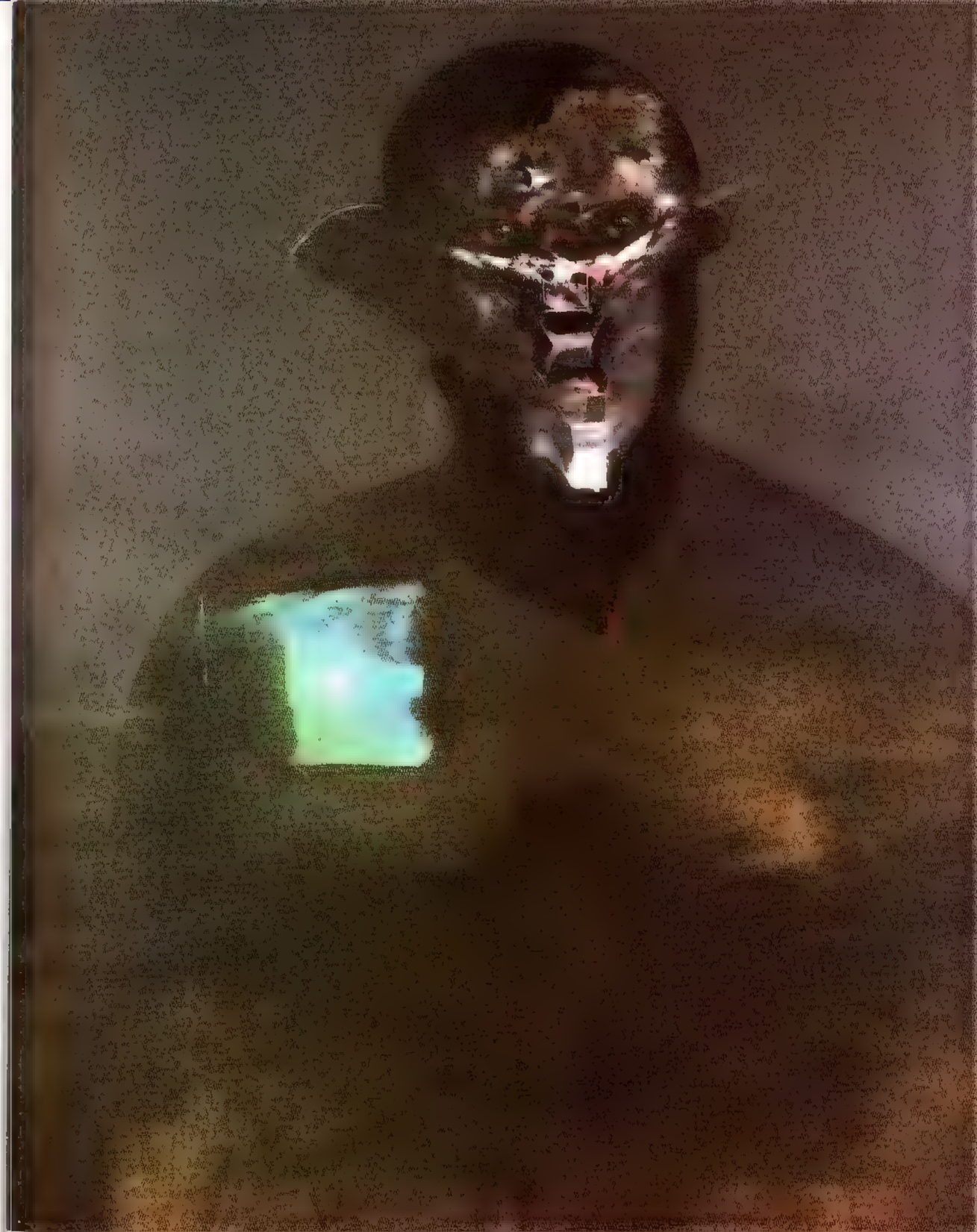
"I wonder whether Death's doorway will let me pass when my time comes," he said to me one day, darkly humorous. "Or will I get stuck in it? Halfway in, halfway out? You know, I've been thinking that zombies could simply be people who get stuck in that door. Their conscious mind has gone through, but the automatic mind gets left on our side of it, running the body mechanically."

"You mean the autonomic nervous system, don't you, Ralph?"

"Do I? Do I?"

I'd come to the Sixth Street Thanatology Center only three months earlier from Neo-Theology College after majoring in Death-of-God counseling, and it was something of a shock for me to find someone who, if he plainly didn't believe in God, nevertheless firmly espoused the doctrine of death incarnate. But I had taken a liking to his black jokes, which seasoned his obsession with a dash of pepper.

No doubt this was the way he performed on his own counseling of the dying: he made death seem something of a farce, a Marx brothers comedy. That approach could probably work wonders with some people I've met there. They hate to be



PAINTING BY MARSHALL ARISMAN

contemplative about their demise. They think that it's sanctimonious. Whereas with other people who are still scared—well a poke could be a fine nerve tonic.

Of course, to Ralph deep down this was no joking matter.

I was being given a guided tour of his machine up in his office on the fourth floor of the center. It was a pleasant, sunny room with a gilt framed medieval *Dance of Death* on one wall and, by contrast, on another a large color photograph of the Taj Mahal. The machine which took up most of the spare floor space, was the 'excluded middle' between horror and blissful peace. Ralph had, however, concluded it a way not of greeting death with alarm or with joy but of damned well capturing him.

There was a waterbed-cum-bier impanted with medisensors set within a delicately filigreed Faraday cage which could block out any kind of electromagnetic radiation or isolate any radiation arising within it. Enclosing this cage were polarizable glass walls that could be rendered opaque—turned into an infinite internal mirror. Various tiny cameras and mirrors were mounted within on silver rods, and outside the glass walls were fluorescent screens, an electron scanner and a kind of hooded periscope. Also within were small highly sensitive (to one part in a billion) chemical sniffers alert to the pheromone of death: the complex chemicals released in minute traces by the dying body that we sometimes call corpse sweat. This chemical is akin to the sexual attractor pheromones released by humans and all other creatures, and personally I think it's a normal evolutionary by-product: a warning signal to others in the vicinity.

Most deaths in ancient times would have been violent in one way or another and spelled trouble. Hewitson, of course, thought differently. He had the notion of this molecule as an attractor signal too. It was something that Death would smell and descend on like a mating moth. The death orgasm couldn't happen until Death had been called. This accounts for certain overly protracted deaths: the bodies of such people simply couldn't produce enough of the pheromone.

True to form, Hewitson had managed to get tiny amounts of this corpse sweat synthesized, and he had built a number of prototype death traps designed to release quantities of it and to snap shut on whatever vectored in upon the molecule—with no success. So he concluded that a dying body actually needed to be there.

Despite his qualms at taking life—which he regarded as sacrificing to Death—Hewitson had equipped his second-generation traps with dying animals. But again with no result. Whereupon, he conceived the idea that the deaths of animals and the deaths of people may be different in essence. (He became interested in the Catholic doctrine that animals have no souls and are automatic objects.)

Incorporated in his perfected machine as well then were tiny pheromone taps with the stored drops of the chemical isolated by vacuum and mini-Faraday cages.

His idea was to imitate death: to hypnotize one's self into a deathlike trance, then turn the taps on.

"Do you want me to come down in there?" I asked him—as that what all this is leading up to?"

"And then release the nonexistent whiff of cyanide?" he suggested with a chuckle. "Oh, no, Jonathan, nothing like that. But of course you can try it out for size and comfort if you like. This will be a pretty famous bed soon. Much more famous than your historic beds where Good Queen Bess or Lincoln or Shakespeare slept. Go ahead. I'm not proprietorial."

"Well, thanks, but no thanks."

"I wonder whether I should equip it with cyanide gas or something similar. Then I not only catch Death but kill him too. After all, if you can legitimately shoot someone you catch burglarizing your apartment—

"As I gazed through the hooded periscope into the pearly-lit interior, the empty bier reduplicated itself perhaps a dozen times in all directions before losing itself in a fog."

well, Death is a mass murderer by comparison. The biggest criminal."

I couldn't tell whether he was joking or being serious.

I wonder, in that case, whether I'd be killing Death in general or just the personal death of whoever was in the machine.

"A whole lot of people die every second, Ralph. They die simultaneously. Even if this Death of yours skipped about at the speed of light—"

"Okay, I see your point. I suppose death could be general *and* particular, though." He hemmed and hawed awhile. "If I killed the particular death I'd zapped the bullet with this person's own special name on it right out of the way: swatted it, squashed it, vaporized it—would this person and his hand drifted over the imaginary contours of his subject volunteer as sensuously as a fantasizing soldier stuck in a jungle hundreds of kilometers from a brothel would this person *live forever*? Would I have perfected an immortality treatment? Rich irony, Jonathan, for the Thanatology Foundation thus to defeat its own purpose." His voice hushed, mock-conspiratorially. "Don't breathe a word of this to anyone. Your Neo-Theology College would be up in arms."

I guess it's a way of persuading people to volunteer. I joked in turn. "Roll up, roll up! Come into Hewitson's Death Cage and he make thee immortal with a hiss of cyanide gas. Oh, but you're forgetting something, Ralph. You'd kill the subject that way before you had his death. Baby and the bathwater, Ralph. Baby and the bathwater."

Ah. Ralph looked crestfallen.

But this was all just horsing around. "You're going to try it out yourself then?" I asked more seriously. "But by just simulating death? By pretending? I take it that will be with the Swami's help?"

The Swami is our pet name for our Indian counselor, Mr. Ananda. Ananda has delved deeper into the ocean country state of death-insertion than anyone else I have ever met. (An oceanic state—on the one hand, but he also compares entry into it to a space capsule leaving the familiar earth behind and entering into orbit high above where all minor details are erased. Up on the edge of the endless sea of death space.) Ananda has used deep meditation and self-hypnosis techniques of Indian origin to pump this way station into nothingness, sometimes accompanying the dying down, or up, there in deep rapport with them before returning to full life to report on it. Needless to say, Mr. Ananda has never met Death—Mr. D—on his journeys.

"I've been taking lessons," Ralph nodded. "Admittedly I haven't spent years at it as he has. But I think I can turn the trick. I think so. When I get down deep enough, my own theta thanatos brain waves will start the pheromones of death dripping."

"When's all this going to happen?"

"Next Tuesday. I'll need a few observers. Ananda has volunteered, though he thinks my motives are—well, you understand. But he's cleared a space in his schedule."

"I can spare the time too, Ralph."

"Good man. Now look down here—"

He showed me how the periscope, the optic fiber and the mirrors let the outside observer see around the whole inside of the cage even when the glass walls are mirror opaqued. As I gazed through the hooded periscope into the pearly-lit interior, the empty bier reduplicated itself perhaps a dozen times in all directions before losing itself in a thickening golden fog while the filigree network of the Faraday cage overlapped and overlapped itself within the mirrors.

Tuesday came. Besides Hewitson and the Swami and me there was also present in his office Dr. Mary Ann Szczepanski, our foundation medic looking lovely in tight silver pigtails, her *de rigueur* white coat carving her flanks in ivory marble.

Here then was the mousetrap with the big cheese—Hewitson—soon to be laid out in it: synthetically Gorgonzola scented with death (though it would not be an odor that any of us could pick up consciously) a trap of the non-ethanol variety.

t is a far far better th ng I do now Ralph grinned hamming t up a t e to Swam Ananda s evident d sapproval as c ad n a j n nen smock he wr gg ed through the door of the Faraday cage carefu not to buck e any of the surround ng th n w res He stretched h mself out on the water bier shut the door and ocked it with Ra ph s go den key as per instruct ons The key cha n s pped round my own neck Then turned on the current to the cage at very low power t hummed fa nt y

The g ass wa s descended and ocked together st n the r see through mode Air recyc ng on

You ook ke Snow White shouted Mary Ann check ng his v ta s gns on the read outs But where s the po soned app e?

Hearing her Ralph nodded ron ca ly n the d rect on of Mr Ananda Then Ra ph composed h mse f as Ananda began oud y to ntone a monotonous tape-oop refra n n Sanskr t which Ra ph took up I suppose n duet though I cou d n t hear h s vo ce

Soon Ra ph ra sed his hand and I opaqued the g ass wa s

When peered n through the per scope he was ly ng utter y st ook ng suitab y b anched and corpse ke n the pearly nner ght He ay bes de his m rrored self wh ch ay beside another mirrored se f Toe to toe w th yet others Each n the r g ded cage the bars of wh ch grew th cker as the bod es pro ferated further it was qu te easy to ose the center of focus and get ost At this moment Ra ph s mach ne seemed more ke a dev ce for c on ng corpses

The descent nto the death trance took the bes part of an hour Mary Ann mon tored Ra ph s v ta s gns dut fu y the whoe t me The sun shone n through the w dow upon what seemed ke a great marb e b ock a wh te kaaba a mausoleum A be draggled p geon strutted to and fro for a wh e on the w ndow edge Distant street sounds d fted up and a few times the wh rr ng of copters beat down Otherw se t was very q et

Mr Ananda peered at the bra n wave screens He tapped one w th a s m brown f nger and mpeccab y man cured na Here s the beg nn ng of the theta thanatos rhythms

I hugged the per scope hood around my head and heard on y the Swam s voice The other rhythms have f attened out now t take four or five minutes more before the theta thanatos is fu enough to switch on the pheromone dr p But wasn t about to pu away I had no nt ent on of miss ng anyth ng not that I be eved there wou d be anything and a videotape was running, anyway But I m ke that Set me on a h top and te me to count shoot ng stars and I watch a night for a friend

Ah Pheromone dr p on now Mr Ananda announced

I sn fted ref exive y even though I d have sme ed nothing whether the experiment had been enc osed n g ass or not

I watched the point of the need e, near Ralph s bare ca f wa t ng at Mary Ann s command to plunge a mass ve dose of st mu ants nto h m shou d the need ar se kept my hand on the button that would mu t p y the power fed nto the Faraday cage f fty fo d

What saw then d dn t record on the v deotape as if the tape cou dn t reg ster ght of the wavelength saw as if t came from a different spectrum entire y! But my eyes saw t I swear t

A red (except that it wasn t red) th ng appeared abrupt y perch ng on Ra ph s chest t was ke a bat it was like a g ant moth it was ke an ange on a Chr stmas tree um nated by fr ght f ickered strobe ke It seemed to dance n and out of ex stence It had big glass y eyes a d at ny sharp beak t had scape c aws on ts ve ke wings if they were w ngs ke the spurs that are fastened on fight ng cocks rea zed that was see ng on y what my eyes and bra n could see not necessar y what was actua y there y

Theta f na e sang the Swam and cou dn t see any of th s St mu ants Mar, Ann

a ready have The s gns show

I squeezed my button for a the t me t wasn t needed Whatever Ra ph had set up to trigger the power ng up of the cage had a ready done its job The cage crackled w th f fty fo d ns u at on

The need e had s d nto Ra ph s pa he jerked ke one of Ga vani s frogs

He sa upr ght on the water b er e es w de open

The red th ng eaped from h m t cage phas ng n phas ng out but m out) It h t the s de of the cage and seemed to pass through the e ectr fied b es and the g ass wa s too But n through yet not nto the room We had passed through nto one of the ref ected doub es of the cage actua y, nto a wor no or g na behind n the rea cage rea zed as hadn t ear er that there had been on y one of t a a ong from the moment of ts f rst appearance No ref ec t ons No dup cates Many ref ect ons of Ra ph but none of t How cou d someth ng I cou d see w th my eyes not possess a ref ect on in a mirror? Perhaps t had to do w th ts own nd v s b e essence

The red moth beat from one phantom cage to the next c r c ng outward from the rea Ra ph He w tson But as it got farther away the go den bars th ckened Now t was fly ng into a wa of increas ng y th ck syrup It could get no farther out through the ref ect ons

Ra ph s t ting upright and fo ow ng it w th h s gaze grabbed in the air w th both hands The a r above the rea water b er was of course empty The th ng Death wasn t there But a the hands of a h s ref ect ons grabbed in un son n a the m rror cages He seemed to know exact y what he was doing

Death f apped frantica y around the c r cu t from one cage to the next to evade his hands But it was all one cage to Ra ph

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He caught it. He caught it in a cage thrice removed from the original. His reflection's hands closed on it and held it tightly. His own hands — and those of all the other reflections of him — were empty. But not that pair. Not those. They held the red thing. The bat moth. Death.

Death slashed at his hands with its wing claws and gouged with its beak. Blood ran down the hands and wrists of that one reflection. The real Ralph cried out in pain. Yet his hands showed no trace of wounds. Only the hands of the one mirror image that held the creature were flayed, but he felt the pain. He continued to wrestle with the creature. Face distorted, he held on, two empty hands cupped in midair, sinews standing out. And however much it hurt him, however much flesh it tore from his phantom fingers, his finger bones still held it securely out in the reflection.

"What's happening?" Mary Ann called. "He's overreacting to the stimulant. What's happening, Jon?"

"He's fighting Death," I cried. "He's caught Death, and he's fighting it!"

Just then Ralph turned to face me, toward where he knew I must be. "Depolarize! Transluce the glass!" he shouted.

I tore myself from the periscope hood, found the switch, and hit it. Immediately all of us could see through the cage. And of course all of the reflection worlds had disappeared.

But Ralph still wrestled with thin air. His fingers still clutched. Ah, I could see what he was doing, though to the others it must have seemed an insane pantomime. He was tearing Death free so that he could hold it in one clenched hand — to throw it far away from him? No, he'd never give up his hold on Death now that he'd succeeded. He held that one imprisoning hand aloft in a kind of open-fisted salute, grinning through his agony, baring his teeth.

"Cut the current!" he ordered harshly.

"Squeezed the bulb. The crackling hiss faded away.

"Unlock the cage, Jonathan!" Even in his pain he refused to abbreviate my name.

"Hesitated briefly. Was I in effect letting Death out into the world? But with the current no longer flowing, I suppose a mesh of wires could be no obstacle.

Ralph saw my hesitation. "You fool, I've got hold of him!" he shouted in my face from the other side of the wires — which he could have burst through by main force, but even *in extremis* he had no wish to damage any part of his invention. Anyway, he isn't *here*. Not in this here. He's still in the reflection — and I've got him tight there!

Had he? Had he really? Or was the pain so deeply etched into his torn nerves and scoured finger bones that he only thought he had? Was he only feeling the ongoing fight in the way that an amputee still feels intense pain from a severed phantom limb? As he continued to clutch the air and bite his lip, I couldn't believe that. The reflections had gone away, wherever reflections go when they're off duty, but his reflected hand was still clutching Death out there, mimicking the shape and stance of his real hand here.

I tore the key from my neck, snapping the chain in my haste. I jabbed it at the lock a few times before I got it in and turned it.

I pulled the door open. Ralph crawled out and stood, his clenched empty hand at arm's length, triumph and torment on his face.

Three days have gone by now. Ralph hasn't slept a wink — doubt that he could let go now if he wanted to. His hand and Death are too intermixed, claws trapped in bones, bones binding wings. His hand remains bent like that of the worst victim of arthritis, unable to flex, yet to all other appearances a perfectly unblemished hand.

"Hysterical cramp," is what Dr. Sczepanski diagnoses about his hand. She doesn't believe what I saw. Neither does Swami Ananda. They know there's no such thing as Death, and the videotape only shows Ralph alone in the cage, then suddenly jerking erect and scrabbling at the empty air.

I'm alone with him now in the office. It's night. Many deaths occur at three o'clock in the morning. That's the dead point between night and day, the hour of despair, the low point of the body rhythms. Right now it's one thirty. Ralph sits slumped in his chair, kept awake by pain, his clenched hand resting on his desk.

"You saw, Jonathan."

"I saw. Yes."

Mary Ann believes that I autohypnotized myself by staring through that periscope into the reduplicating mirror room too long. My attention drifted away into the mirrors. I was virtually in a state of sensory deprivation. I was hallucinating freely and grandiosely when Ralph jerked upright and began his phantom fight. I was seeing a mote in my own eye. I gave it unreal life. Just as Ralph, torn out of deepest trance, blood pounding through his heart, saw that blood personalized in midair as the rooster, the bat, the moth of death.

"You believe me now, Jonathan."

"Believe? I *know*."

So Ralph sits before me, holding Death at arm's length — though for how long? When Death at last escapes from him, does it wing elsewhere, or does it come directly here? Homing in, to perch on the real hand whose mirror image holds it at bay, captive in the realm of reflections?

"It feels as if my bones are coming apart," Ralph groans. But maybe they aren't at all. "This hand's still solid. Oh, my too, too solid flesh! But I can't *see* them, the other bones. I only feel. God, what I feel!"

"Let him go. Open your hand."

"I can't, Jonathan. I can't."

It's a quarter to two. Outside, the city is as still as a sepulcher. Silent night. Ralph is too weary to scream.

Together, we wait. ∞

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THE ARTS

By Jeff Rovin

Advertisements for *Flash Gordon*, the recently unveiled film epic, have dubbed its protagonist the Greatest American Hero of All Time. It's an arguable claim, certainly the eclectic group of Superman, Popeye and the Lone Ranger—all of whom like Flash Gordon are currently represented by big budget films—are no less great, no less redblooded. However, since heroic Americana is enjoying a renaissance there is at least one crown that can be placed upon the platinum blond locks of the durable space warrior. Having engaged in unequal combat with more alien creatures, in more exotic lands and with more fantastic weapons than any other fictional heroes, Flash Gordon is surely the Greatest Science Fiction Hero of All Time.

Flash is the creation of artist Alex Raymond, who began publishing the comic strip escapades of his athletic Yale man on January 7, 1934. Flash proved remarkably popular in that medium, though even greater prominence awaited him in 1936 with the release of the first of three motion picture serials starring Buster Crabbe. Since then, Flash has remained on display in a series of novels and long-running comic books, on television in both live action and cartoon programs, and as a mainstay of toy guns and coloring books. Now he has settled in his biggest and grandest incarnation, a $30 million motion picture produced by Dino De Laurentiis and scripted by Lorenzo Semple, Jr. with additional assistance from *Dune* author Frank Herbert. Starring as Flash, bravely carrying on the Earthly powers that money and imagination can buy, is dashing film newcomer Sam J. Jones.

Jones is a personable and enthusiastic actor who, before *Flash Gordon*, was best known for his role as Bo Derek's boyfriend in the movie *10*. Appearing at a casting party as a contestant on *The Dating Game*, he was chosen, money he confesses, Jones caught the eye of De Laurentiis, through the actor's then-wife, and was offered a screen test and a weekend that ended one of the most coveted film roles to come along in many a year.

Jones spent six months being Flash, charging through hyperspace to the planet Mongo, swimming through monster-infested swamps and battling the minions of Ming the Merciless with swords, whips, ray guns and fists.

"I took my lumps and bruises saving the earth," Jones quips. "But when I'm cast for a film by Fellini, I want to be a part of the film. I used to get Dino and our director Mike Hodges' spotlight because I'd be so involved that I'd overdo things, like the fight scenes and end up getting hurt. They had to settle me down before I killed myself. But I wanted to add as much as possible to make the film work."

So he did. For months before the cameras rolled, the six-foot three-inch actor ran six miles each day, then worked out in a punishing regimen of pull-ups, pushups and weight lifting. He also did my homework. He boasts, reading the old comic strips and getting in touch with science fiction buffs who could tell me in or the ghastly denizens of the Flash Gordon universe, from the Hawkmen of King Vultan to Thun the Lion Man to Prince Barin. Since I was never really a big science fiction fan, it was a quite interesting adventure," he says, as if surprised by the fact.

However, Jones says quickly, at no time did he let the texture overwhelm Flash, reducing him to a muscle-bound figure who does nothing more than cross his arms imperiously and flex his muscles while looking at the strange costumes and scenery.

Jones says that what was important to him and to the filmmakers was to make Flash as believable a character as possible without changing the look and feel of the property. "We stuck close to the comic strip as far as the sets and story went, and we retained most of the original characters. We couldn't allow ourselves to worry about things like whether the Hawkmen made aerodynamic sense. They're an inherited part of the legend. People have certain expectations about Flash Gordon. You can't let them down or they'll tear the theater apart."

Remaining faithful to source materials is apparently a lesson De Laurentiis learned when his brutalizations of *King Kong* and

Guarded by Hawkmen, Flash and Prince Barin engage in pitched battle on a swaying disc.

Hurricane topped at the box office. Thus the only fundamental tinkering in *Flash Gordon* is with the framing story, wherein Flash, Dale Arden, Melody Anderson, and Dr. Zarkov, Chaim Topol, head into space to prevent Ming, Max von Sydow, from destroying Earth. The story has been updated to the 1980s, and as a result Flash is no longer a polo player but a quarterback for the New York Jets.

Either way, Jones says, he's a natural leader who doesn't like to be beaten. He doesn't have any real knowledge of science, probably took PE in college, and when he's thrust onto this planet Mongo, he's a bit uneasy about it. One would have to be uneasy on a world where the inhabitants spend most of their time slitting one another's throat. But if Flash doesn't have great intelligence, he has wisdom and experience, and he's not a quitter. When his instincts start ticking, he becomes a character who's truly a hero in the classic sense of the word. He's ready to risk life and limb for a cause he thinks is just.

The Greatest American Hero? Jones smiles. "I don't know about that. But he's the kind of hero America needs today, a human hero, a man who's more than just macho. He doesn't have any big, heavy emotional scenes. He doesn't cry or anything like that. But he's vulnerable. When he's caught or hurt, the audience jumps out of their seats. They care. When he saves the life of a man who's been trying to kill him, they admire Flash. If you have a hero whose actions are totally familiar to you, who is two-dimensional, or who can't be stopped, if you have a story where the expectations are obvious, then where's the power, where's the surprise?"

The actor adds, tongue in cheek, "Flash is sometimes a little naive. For example, Zarkov dupes him into entering the space capsule by telling him that it's a phone booth, but I think those campy, innocent elements help to balance the more serious and intense scenes in the film."

At twenty-six, Jones is part of a generation that has become sensitive to the radical changes in the human condition, on screen and off. As hard as he and Melody Anderson worked to make the relationship between Flash and Dale credible, it still exists within the obviously sexist framework of the story. Yet Jones is thoroughly dedicated to sexual equality.

"Flash is fairly traditional. He looks at Dale and, while she is attracted to his warmth and courage, his first question is, 'Does she have a nice face and nice legs?' To his credit, it's only when she opens her mouth that he decides that this girl is for him. I'm glad to see attitudes changing, and I would love to see men and women on a genuinely equal footing."

"Despite my conditioning, the conditioning most men my age went through, he adds, "I'm getting to a point where I can cut off the old 'We,' 'I'm the man of the house' thing with my fiancée. I look forward to more of these kinds of basic changes in our future society, when men can talk about more than 'We,' the Mets won today or 'How about deer hunting next weekend?' Boys in high school can take ballet class and not be classified as effeminate. Which is a BS as far as I'm concerned."

"Jones is realistic about where human relationships may be headed. "I'm far more pragmatic about the film industry and where it's going. I don't agree with what most people are saying, that our fascination with television and movies is a bad thing. As a society, we're advancing and growing. Since you can't get rid of progress, you have to work with it. The nuclear-power plant that they tried unsuccessfully to shut down in Maine [Yankee Freedom] and the Titan missile that exploded in its silo are extreme cases, and it's an unfortunate fact of life that the more we advance, the harder it becomes to avoid certain risks. Films can help people adapt to change, can explain things better than books can, better than *Oliver Twist*. I'm not putting down Charles Dickens, but I've seen audiences come out of movies about something currently topical, such as *The China Syndrome*, and say, 'My God, I didn't know anything about that.' What's wrong with people getting some of their information on current events from the movies?"

Jones is typical of the new actors working in this era of vast technological advances and equally vast technological upheavals in the film industry. My understanding of science is limited to the mechanical and optical effects seen in movies, though I look upon new inventions with interest and joy." He says he's familiar with all the latest developments from cable television to video discs and recorders and believes that his fellow actors were justified in striking last summer to earn royalties from these proliferating new outlets.

"The producers are going to make some money. I know that. Given this fact, I don't see why everyone wasted one another's time. I'm the type of person who would have walked into those negotiations and said, 'This is the way things are. They're new ways, but so what? Let's face them and work them out. I like to get things done. I've always felt this way, even when I was driving a truck or working as a dishwasher. I've learned to expect the unexpected on every front, deal with it, and move on."

Because he looks forward to the accelerated importance of film and television in the future, Jones has formed his own production company. He plans to be involved with filmmaking not only as an actor but also overseeing all phases of film production, including the marketing of video cassettes. "And ultimately, if I'm successful, I want to give talented people a chance to share their experiences and insights through film, the way Rod Serling did on *The Twilight Zone*, a show that I watch whenever I can. Talent shouldn't be ignored just because people don't have the proper contacts."

Jones recalls an event that serves as a fitting comment on his ambitions. "A man walked up to me and said, 'I've been wanting to meet my son for a long time.' I looked up, and there was Buster Crabbe. I said something dumb like, 'How ya doing, Pop?' But it really was a thrill for me. You should see him. The man is seventy-three years old, and he has more energy than most people my age. I was glad to see him so fit and happy." Jones admits that the future might hold few greater rewards than if some kid recognizes *him* a half century hence and feels that same jolt of excitement.

Whether this ever happens, whether he follows in the footsteps of Buster Crabbe as one of the screen's great action stars or realizes his broader goals, one thing is certain. For Sam Jones, *Flash Gordon* is a giant first step. ∞

Flash Gordon is sentenced to death while Doctor Zarkov (upper right) looks on helplessly.

EARTH

CONTINUED FROM PAGE 20

fertilizers and pesticides. The U.S. Department of Agriculture's Report and Recommendations on Organic Farming issued last July suggested that composting processes could be devised to improve the nutrient and tilth value of municipal refuse and many industrial wastes.

New guarantees of soil conservation also can be met by breaking a few bad agricultural habits. Wes Jackson of the Land Institute in Salina, Kansas, proposes a shift toward perennial agriculture. Historically, society's tendency has been to farm the monoculture of annuals. But nature's pull, says Jackson, is toward a polyculture of perennials. Our ancient decision to go with annuals, Jackson suggests, perhaps was a wrong turn. Annuals do have many virtues as food plants. They are enterprising, grow fast and convert solar energy into harvestable seeds. But their cultivation, especially in monocultures such as a field of corn, leads to erosion. Annuals require that the soil be unvegetated for long periods each season, periods when the soil is vulnerable to wind and precipitation. For row crops such as corn and cotton, the soil between rows is bare even in the growing season.

Present-day farmers make considerable use of perennials: apple, almond and citrus trees, blackberries, grapes. We know that the elaborate root systems of perennials are good soil binders. Perennial agriculture does not require that the land be scraped clean at the end of each growing season. Most of a modern farmer's fuel expense is in seedbed preparation and cultivation of annuals. With perennial agriculture this cost would be lowered. It would reduce dependence on chemical fertilizers and lessen the need for pesticides, especially if utilized in polycultures.

Mankind has directed very little of its overabundant imagination to the development of new crops. We make use of less than 1 *percent* of all the known species of seed-producing plants. Fewer than a dozen species provide most of our food. Jackson and his colleagues are experimenting with Eastern gama grass, *Tripsacum dactyloides*, a perennial relative of corn whose protein percentage is three times that of corn and twice that of wheat.

What the earth needs right now are fewer ingenious ideas and more good deas. The best ideas for soil preservation are those that approximate natural systems. The monoculture of annuals is not a natural idea. Neither are the biomass harvesters who have built their scheme on the false example of leaf-consuming microbes. The microbes become a component of the living soil by returning large measures of humus for the heat this process liberates. The closest analogue in nature for biomass conversion is fire, which leaves ash for the forest that will come after. ∞

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THE ARTS

By Marc Kaplan and D R Bensen

Today as never before sc ence books are break ng nto the best seller lists disp ac ng cookbooks and m steries in bookstore w ndows Th s past year a one for ex ample John W W ey & Sons one of the nation s most prom nent sc ence book pub shers published 279 more science t t es than in 1979 To he p readers assess th s r ch f ow of sc ence books *Omn* has assembled a pane of four dist nguished judges to se ect the **Ten Best Science Books of 1980** Here are the r choices

The Search for Solutions Horace Free and Judson (Hol Rinehart & W nston $16 95)
The Big Bang Joseph Silk (W H Freeman & Co $9)
Galaxies T moth Ferr s (Sierra Club Books $75)
Corridors of Time Ron Redfern (T mes Books $55)
The Panda s Thumb Steven Jay Gould (W W Norton $12 95)
Hands John Napier (Pantheon Books $13 95)
The Micro Millennium Christopher Evans (Vik ng Press $10 95)
Dawn of Modern Science Thomas Goldstein (Houghton Mifflin $12 95)
Hans Bethe The Prophet of Energy Jeremy Bernste n (Basic Books $12 95)
Freud The Man and the Cause Rona d W C ark (Random House $19 95)

Four judges were mpaneled to assess the past year s output of sc ence t t es Gregory Benford professor of phys cs at the University of Cal fornia at Irv ne Gilbert Cant medical and m litary wr ter Brian Fagan professor of anthropo ogy at the Univers ty of Ca fornia at Santa Barbara and Martin Gardner science wr ter and mathemat ca co umnist for *Scientific American*

The pane s clear favor te is Horace Free and Judson s *The Search for Solutions* t s not hard to see why Sc ence Judson says is our country s art and this book respectfu y demyst fies exact y how scientists do sc ence Its e ght chapters focus on particular aspects of the sc ent fic method pattern change chance feedback mode ng pred ct on ev dence and theory Judson s c ear expos tion of such thorny concepts as partic e physics and protein synthes s is set forth with extraord nary grace s m p c ty and sensit v ty What emerges is not only a h story of the sc ent fic method but Gardner says an apprec at on for the greatest of a mysteries how the human mind s able to know the structure of the wor d n which it finds tself

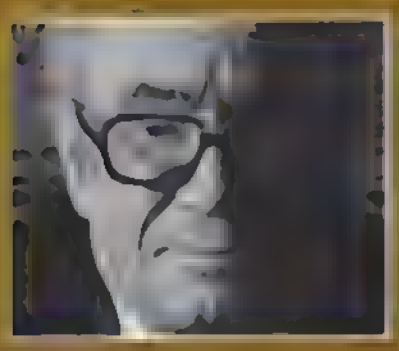
Masterpieces of scientific investigation are the sub ect of Judson s award winning book

That world expands to a un verse of awesome possib t es in two recent re eases S k s *The Big Bang* and Ferr s *Galaxies* Dr Benford descr bes S k s book as a we gu ded tour of cosmic evolut on briskly p ot ng its readers through newly charted waters of ga act c or gins ste ar evo ut on and the format on of heavy e ements n lucid but techno og ca la guage S k br ngs the phys - cal and chem ca underpinnings of the heavens within our grasp

Ferr s *Galaxies* offers a more nspirationa approach to the same sub ect The author nvents an maginary starsh p that conveys the reader to the center of the M lky Way, through intergalactic space beyond ga act c superc usters and out to the edge of the universe The text s informative and accessib e Ferr s s not shy about letting his mag native metaphors reflect the beauty and wonder he observes But the book s real strength es n its photo graphs our ember sun ghost y wh rlpoo s of spiral galaxes starry pastures of nebu ae According to Professor Fagan, these powerfu images reinforced by Ferr s s yrica sty e set new standards n sc ence publishing

Ron Redfern s *Corridors of Time* a viv d photograph c examination of the Grand Canyon a so draws upon the t me-trave image This ourney however returns to the earth of 1 7 b on years ago Geological upheavals and eros on n the terrain have left huge escarpments and deep troughs These are the mu t hued corr dors of t me anc ent landscapes that date from the new y formed gaseous protop anet that wou d eventually support organ c fe For th s project Redfern deve oped a

NEXT OMNI



around. Yet as the computer reduces the drudge work in offices and the physical labor in factories, workers will have more and more leisure time and the number of unemployed people will soar. Evans's book judiciously portrays both the blessings and the perils of this microchip revolution.

Modern science did not begin only in the sixteenth or the seventeenth century. Even Isaac Newton, arguably the greatest scientist of all time, recognized that he stood "on the shoulders of giants who had gone before." But today, Gardner says, "the debt modern science owes the Renaissance and the Middle Ages is so often downplayed or ignored completely."

Thomas Goldstein's *Dawn of Modern Science* demonstrates that many key principles of present-day architecture, astronomy, chemistry, mathematics, and medicine originated in the Middle Ages. Of special interest are the contributions left by the Islamic culture to medical care and surgery, mathematics, and empiricism. Goldstein shows how the Middle Ages and the Renaissance produced more cohesive societies than students of those periods perhaps previously thought, and that the knowledge and practice of one discipline were picked up and used by another. This interdisciplinary meld produced the cathedral at Chartres, and the artistic discovery of perspective benefited virtually all the empirical sciences.

The Middle Ages were characterized by the belief that the same forces manifested in nature also governed human behavior. Modern psychoanalysis is still engaged in applying the insights and methods of the natural sciences to the conduct of human affairs. Ronald W. Clark's *Freud: The Man and the Cause* chronicles Freud's struggle to quantify the mechanisms of the unconscious. Clark follows Freud's association with Wilhelm Fliess, Carl Jung, and Ernest Jones, the birth of psychoanalysis, the famous case histories, the study of dreams, and Freud's use of cocaine. Clark, who has written on the lives of Einstein and Bertrand Russell, utilizes his instincts as a biographer instead of adopting those of a psychoanalyst. Clark's biography is mercifully more concise than Ernest Jones's long-time standard work, Cant says.

Hans Bethe has been called "the great craftsman of physics." Bethe's careful, thorough, personal approach to theory and experiment, and his wizardry with numbers, placed him in the vortex of physics history, and in 1967 he won the Nobel Prize for discovering how the sun works. Jeremy Bernstein devotes the opening parts of *Hans Bethe: The Prophet of Energy* to Bethe's school days in Germany, where he, Linus Pauling, and Isidor Isaac Rabi exchanged ideas concerning the new science of physics. Later Bethe emigrated to the United States and became involved with the development of the A and H bombs and subsequent nuclear weapons controversies. But it is the final portion of Bernstein's book that distinguishes it from conventional biography. Bethe in the past few years has dedicated himself to the physics of energy. The energy problem, as Bethe sees it, is more complex than the purely technical feat of developing new energy sources, Bernstein says. "We are dealing in futuristic estimates [of resources] on which honest and informed people may disagree. What is essential is to develop a sense of these limits and a general feeling for what is true and what is not." Bernstein presents Bethe's analysis of future energy sources with consummate impartiality, whether nuclear, solar, oil, or coal. Bethe sees his role as educating the public and the government so that they can make informed decisions. His viewpoint is particularly valuable. As a physicist, he is able to assess the scientific realities of any chosen energy policy. "This is a book," Benford cautions, "that should be read by every American."

With almost every passing week the world is becoming better understood and [illegible] important to have this world [illegible] and precision, each [illegible] Best Books [illegible] a pre[illegible] corner of the world. Dr. [illegible] in his preface to Judson's [illegible] "We need people who can tell [illegible] is done [illegible] why it is done [illegible] how to distinguish among good [illegible] and nonsense. ∞

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STARS

By David K. Lynch

Astrophysics benefits from new technologies. It seldom contributes to them. But in the not too distant future the stars may teach us how to build devices that are now only physicists' dreams. To see why, let's go back a few years.

In the mid-Fifties the first successful maser was hailed as a dramatic technological breakthrough. Physicist Charles Townes of the University of California at Berkeley eventually received the Nobel Prize in physics for the invention. But by then radio astronomers on the Berkeley campus found that Townes had been scooped by someone who didn't need a jungle of coaxial cables, power supplies and strip chart recorders to build a maser. Mother Nature had been doing it for billions of years.

Masers and lasers operate because of the way atoms within them absorb and release energy. Atoms can't take in simply any amount of energy. They hold it only in fixed amounts. So they absorb and emit only radio waves or light whose energy is exactly equal to the difference between any two of these fixed energy states.

By handling the atoms in just the right way it's possible to pump the same amount of energy into a large number of them at once. But these excited atoms are highly unstable. When light of just the right energy passes through an excited gas, each photon can force an atom to give up its energy in the form of an identical photon. The two photons trigger other atoms, and before long an electromagnetic avalanche is under way. The resulting light can be millions of times brighter than an incandescent lamp burning at the same temperature.

In 1963 Harold Weaver and his radio astronomers at Berkeley were studying the radio waves emitted by hydroxyl (OH) groups in the Orion Nebula, the nearest region in the galaxy where stars are still being formed. Hydroxyl emits some of the brightest radiation of all the molecules.

Weaver and his colleagues were astounded to find that one part of the nebula showed a bizarre emission spectrum. Its line intensities were all wrong, and one was so strong that Weaver suspected it of belonging to a different molecule altogether. They dubbed it Mysterium.

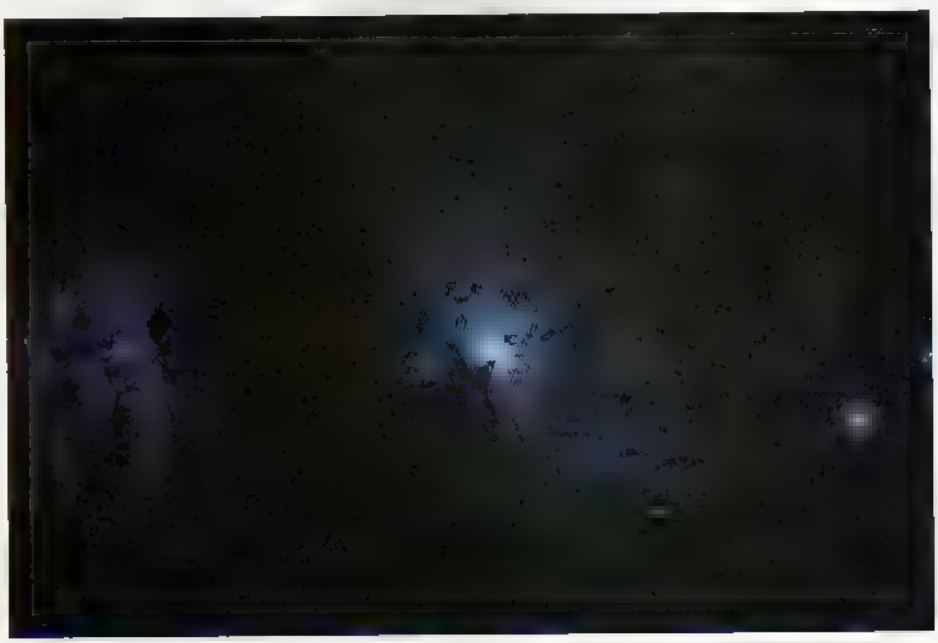
Before long, however, the evidence was clear. Mysterium was simply OH. But the OH had formed a natural maser. The molecules were being pumped by infrared light from nearby gas clouds that were collapsing to form stars. Since then, hundreds of interstellar OH masers have been discovered.

In 1968 radio astronomers at MIT discovered a second type of OH maser, in variable red giant stars. With diameters several hundred times that of the sun, these stars have burned their primary nuclear fuels and are in their death throes. As they tremble and quake, they eject gases that forms a shell around the star. When this cools to a few hundred degrees Kelvin, it forms molecules that can function as masers.

The next year brought the discovery of the stellar water maser. Soon after came the strangest one of all: the silicon monoxide (SiO) maser. Unlike the abundant oxygen and hydrogen of hydroxyl and water masers, silicon is relatively scarce. Stranger still, when astronomers identified the exact molecular energy levels in these masers, the SiO molecules proved to be between two highly excited states. Such stellar masers can exist only in regions of the circumstellar shell that are at about 1,000 degrees Kelvin.

So far only molecular masers have been observed. But in principle there is no reason to believe that Mother Nature has not also built optical lasers, chemical lasers, free-electron lasers and possibly even gamma-ray lasers, or grasers. They would probably form near hot stars, novas and other violent objects that can emit high energy radiation to pump the atoms and nuclei. Physicists all over the world are now working to build many of these devices. Learning how Nature accomplished it could do much to speed their success.

And it's a pretty good bet that she is operating exotic lasers that we humans haven't even thought of yet. ∞



The Orion Nebula's hydroxyl masers (above) were the first identified by human physicists

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GAMES

ANSWER TO GAMES PAGE 116

1. THE LOPSIDED COIN. To determine a binary digit it is necessary only to flip the coin twice. Since the coin is unfair the outcome heads heads (HH) will not occur with the same frequency as tails tails (TT). But the sequence HT is as likely as TH. No matter how biased the coin may be. You simply flip the coin twice for each trial rejecting both HH and TT, then designate HT as one and TH as zero, or vice versa.

2. PENTAGON SPY. Imagine that the man has a doppelganger directly opposite him on the other side of the Pentagon's center and the same distance away. If either man sees three sides, his double must see only two. Since the man may be at either spot with equal likelihood, the probability that he will see three sides is 1/2.

3. VIGNETTE. One is tempted to say 1/2, but this is wrong. Had the statistician said that his older child is a boy, then the probability that the other is a boy is 1/2. But having said that one is a boy, there are three equally likely possibilities: boy-boy, boy-girl, and girl-boy. In only the first case are both children boys. Hence the probability in this question is 1/3.

4. PARADOX. The fact that you hold a pair actually increases the probability that your opponent also holds a pair. Your pair reduces the variety of cards remaining in the deck, which increases your opponent's chances of drawing two matching cards. If you hold four of a kind, the probability of any opponent's holding a pair is about 10 percent higher than if you hold nothing.

5. BETCHA HALF. Since I won as many times as I lost, the total of bets was an even number. On the average, out of each pair of bets I lost one and won one. In the long run, then, each pair of bets reduces my bankroll by 1/4. This payoff is remarkably similar to that of some recent stock-market investments.

6. TWO STRAIGHT. If Junior is to win two games in a row, he must win the second game, so it is to his advantage to play that game against the weaker opponent. He must also win at least once against the stronger opponent, his father, and his chances of doing so are greatest if he plays his father twice. The first game should be against his father.

7. HAT TRICK. Junior's best strategy is to put a single $10 bill in one hat (A) and the 19 other bills in the other hat (B). The odds on drawing a $10 bill from hat A are 1/2 × 1 = 1/2. The odds on drawing a $10 bill from hat B are 1/2 × 9/19 or 9/38. The sum of the two probabilities is 14/19. There is an almost 3/4 chance of Junior's picking a $10 bill and getting his allowance bonus.

8. LICENSE TAG. If you took this bet, you didn't learn much from the birthday paradox. The same sort of calculation is involved. Actually the odds are 7 to 1 that of 20 license plates at least two will have the identical last two digits.

9. STRING THING. Follow the lace down from the upper left and through the first three intersections. Use capital letters to designate passing over (ABC), small letters for passing under (abc). There are eight possible ways the lace can cross itself, and of these only two (AbC and aBc) create knots. The probability of getting a knot is one in four.

10. KIDS. Most people guess (1) two boys, two girls, but the correct answer is (2) three of one sex, one of the other. Of the 16 possible combinations of four children, in eight of them there is a three-one split. In only six is there a two-two split.

11. BIDS. Open the first bid and use it as a standard. Accept the first upcoming bid that is less or the last bid if none is less. Four bids ranked 1 2 3 4 may be opened in 24 possible permutations, and the above strategy results in picking the lowest bid 11/24 of the time. If a large number (N) of bids is involved, the best strategy is to compute N/e (e is the transcendental number 2.718...), find the nearest integer, open that number of bids, and accept the next one that is lower than any of those bids.

12. CARD MATCH. The probability that at least one card will be dealt as it is named is greater than one might suppose—almost 2/3. In fact, since most people assume the chances are about 50-50, this qualifies as an excellent sucker bet.

13. SIC TRANSIT. This dice game is nontransitive. Die A beats B (probability 21/36), and die B beats C (probability 21/36), but die C beats A (probability 25/36). The best Jimmy the Greek can do is minimize his losses by choosing A.

14. NAUGURAL BALL. The probability is zero. If nine hats are correct, the tenth must be correct as well. ∞

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POLITICS

CONTINUED FROM PAGE 54

had foolishly restrained his program. Hirsch scoffed at the administration's plan to put a demonstration plant into operation by 2015 or 2020. In a harmonious duet with McCormack, he told a hearing in December 1979 that there was no reason to hold back and every reason to get on with it.

"The program has reached, and in many cases surpassed, the goals publicly set forth in past years," Hirsch declared. "Magnetic fusion research has consistently been on schedule and very close to the cost estimates, even during recent inflationary times," he stressed, hoping to ease fears that yet another high-tech project might produce catastrophic budget overruns and unmet deadlines.

Hirsch emphatically asserted that his "panel felt the magnetic fusion energy program was, without a doubt, ready to proceed much more aggressively than projected." He called for a $1 billion-class experimental fusion-power system. "It was the panel's view," Hirsch continued, "that this step should be formally initiated in the near term ... because a delay would substantially reduce the effectiveness of the ongoing program."

An engineering test facility, he said, should be in operation by 1987, with a demonstration plant on line before the year 2000.

The next witness was another true believer, Edwin Kintner, Hirsch's successor as DOE's associate director for fusion energy. Now McCormack went into rhetorical orbit about the virtues of fusion. "The development of fusion power will be clearly one of the most important events in the history of mankind," he said.

Then he asked Kintner, "Do you see any reason why we should not compress the schedule? Do you see any reason why we must take our steps sequentially? Is it not realistic to try to take them somewhat in parallel, and therefore not wait until we have every detail from one project before we start the next?"

Kintner picked up the melody. "That's a very unfair question you're asking. You know without asking, that is, I think you know my position ... we want very much to proceed absolutely. We believe we are dealing with the future of the [human] race."

"I apologize for asking an unfair question," McCormack replied, "should ask it of the President, the secretary of Energy, and the director of OMB. I won't put you under the gun."

"Thank you," Kintner said.

McCormack's next step was a direct challenge to Jimmy Carter. In a letter he urged the President to "declare the development of magnetic fusion energy as a major national priority." McCormack requested a fusion budget of $500 million for the fiscal year starting on October 1, 1980, roughly $150 million more than the administration had planned. Researchers, he added, should be authorized to get moving at once on the next big step, the engineering test facility.

McCormack kept hammering at the idea that fusion rapidly make the transition from physics to engineering and that Carter, then reeling under accusations of failed leadership, must take charge and not be bound by fainthearted, pennypinching advisers. Quoting from the Bible, "Where there is no vision, the people perish" (Proverbs 29:18), McCormack advised Carter that the Hirsch panel included "the finest scientists, engineers, and industrial managers in the world," and asked, "May I hear from you soon?"

Carter swiftly passed this hot potato over to DOE, which appointed yet another panel. This one was headed by S. J. Buchsbaum, a vice-president of Bell Laboratories and a veteran of the advisory process. Of all the recent fusion panels, the Buchsbaum group was widely regarded as scientifically the most sophisticated.

> *"In R&D, Johnny Foster was known as a master of his profession, one who could sort winners from losers early in the game, without wasting time or money through excessive caution."*

The panel listened to fusion specialists, visited the major research centers, and emerged with a verdict about midway between the earlier ones. Buchsbaum, though optimistic, concluded that it was still a bit too early to start on an engineering test facility. "Nevertheless," the report emphasized, "the panel is firmly of the view that the development of the requisite engineering experience requires a broad program of engineering experimentation and analysis having at its focus a test device with a burning, even an ignited plasma."

To the politicians, the answer was clear. Fusion is looking good. So let's get on with it.

By August 1980, when the Buchsbaum report was circulating around the capital, McCormack had acquired some 200 cosponsors for the bill he wanted. It authorized construction of the engineering test facility by 1987 and an operating demonstration plant before the end of the century ... just as the Hirsch panel had recommended. Why were they signing up when the coming election put a premium on pledges to cut federal spending? McCormack explains that fusion has an image that's the best of both worlds. It offers cheap and plentiful energy and it's clean and utopian.

Fusion is one of those rare items in national politics that has managed to elude violent opposition. Amory Lovins, apostle of soft energy solutions, says that fusion is a clever way to do something that we don't really want to do, to find yet another capital-intensive, complex, centralized source of large blocks of base-load electricity. But neither he nor any other influential member of the public interest movement found it worth a serious confrontation. The reason, McCormack says, is simply that fusion is still too far off to arouse public attention.

Touted as the ultimate solution to energy problems, fusion has also begun to give off the aroma of goodies to be shared. High-tech industry, always on the lookout for new government contracts and industrial markets, early last year formed Fusion Power Associates to lobby for a faster development program. With 16 big firms in the charter group, the association set up a Washington area office and strongly backed McCormack's plan.

Meanwhile fusion is gathering a constituency. Senator Howard Baker of Tennessee, for one, has suddenly emerged as a strong fusion supporter. He openly acknowledges that his interest is tightly linked to DOE's big fusion project at the Oak Ridge National Laboratory in his home state. Senator Paul Tsongas of Massachusetts picked up the Buchsbaum theme, urging a faster research program, but not quite what Hirsch and McCormack had recommended.

The final bill calls for a fusion budget of $1 billion by 1987, up from the $400 million originally planned for 1981. By 1990 a Center for Fusion Engineering is to be in operation with a working demonstration plant by the year 2000. The vote in the House was 365 to 7; the Senate then passed the bill by voice vote.

Passage is a declaration that the United States intends to hurry its fusion program along, but the money to pay for it must come through separate legislation. Other projects have bogged down when the funding was not passed, but there is not much chance of this happening when the votes are so overwhelming, nor will McCormack hold still if the budget cutters attempt to abort his achievement.

In fusion circles, it is McCormack who is credited as the prime mover in all this. Ed Frieman, the Princeton fusion scientist who succeeded Deutch as chief of energy research at DOE, says that McCormack is the central figure.

As for the congressman from Yakima, he greeted the bill's passage by saying only, "I mean it." Then he pointed out that Hanford is the ideal site for that $1 billion Center for Fusion Engineering. ∞

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ZIP

LIFE

CONTINUED FROM PAGE 42

donor could be the only alternative. So far scientists have not had to confront this problem directly. But the science of embryonic implantation is rapidly expanding. The same principles that apply to the treatment of brain lesions may be used in restoring other organs, particularly eyes.

Two years ago Richard Wyatt received a strange phone call from two of his coworkers at NIMH. "We know that you, as a psychiatrist, are interested in introspection," they said. "What would you give to be able to peer around inside the mind?"

Wyatt couldn't imagine what they were up to. Yet colleagues William Freed and Mark Perlow were referring to an experiment Wyatt himself had dreamed up. As he soon discovered, they had transplanted a rat's embryonic eye, including the optic stalk, into the brain of an adult rat. Skin, muscle, and bone over the implantation site had been removed. There, sitting in the middle of the brain, was a tiny eye staring out at him. What's more, it appeared partially functional.

Freed had flashed light stimuli into the grafted eye and found its nerve impulses varied with the intensity of the light. How can an eye so far astray from its home territory, still see?

One possibility is that the optical stalk had somehow managed to hook up with the lateral geniculate body, a relay station for visual signals in the brain. Wyatt and Freed are working together to determine exactly what happened. Instead of cutting open the rat's head, they are planning to insert fiber optics through a tiny hole in the skull to see whether the eye can be stimulated by an external source.

Even with fiber optics, an eye inside the brain would not seem useful either to rat or man. But if an eye can grow where it's not supposed to, then why not where nature saw fit?

It is one thing to graft an eye and achieve some electrical activity, Hoffer says, "and quite another to get it to grow into the eye socket with optical stalk wired up to the visual cortex. Nevertheless, he's greatly encouraged by the degree to which embryonic tissues are preprogrammed to recognize, and link up with, the proper targets in the host. To grow a functioning eye for a blind person, the fetal graft would have to establish interconnecting links with thousands of nerves arranged in a fantastically intricate network. But according to Hoffer, the prospects of doing so may be no more farfetched "than ten years ago you said we could treat Parkinson's disease by transplanting embryonic pieces of brain."

Should Hoffer's research or that of his colleagues reach fruition, the "right to life" may take on even more complex ethical overtones: the right to *whose* life—that of the unborn child or an adult suffering from severe physical impairment? OMNI

An invitation to photograph the definitive Omni cover

PHOTO CONTEST

By Geoffrey Gorson

The overwhelming response and superior quality of submissions to the *Omni* Phenomena Photo Contest (see page 78 for results) prompts us to announce the next in a series of photography invitationals. Only three photographic images have found their way onto *Omni*'s cover since the magazine's inception 27 issues ago. This reflects the difficulty we face in finding appropriate cover photography. Our unique editorial focus defies easy categorization. After all, how can the frontiers of space, the promise of technology, or even the fantasy of visionary fiction combine to form one simple photograph? We can give you a clue, however. There's an undercurrent flowing through *Omni*, a view shared by writers, artists, editors, and readers. We are all optimistic futurists. In view of what our readers can accomplish when they put their minds and lenses to a subject, we thought it appropriate to plumb the depths of their creativity for help. The photographic covers we've published thus far:

- Premier issue, October 1978. "Road Song," by Pete Turner. It was shot at dusk along a deserted and eerie road.
- February 1979, an untitled alien landscape created entirely in the studio by Turner.
- February 1980, "Broken Hearts," a sculpture by American artist Nick Aristovoulos, fashioned from polyester resin and several other substances. Photographer Shig Ikeda captured the sculpture on film.

"Road Song," by Pete Turner. October 1978

We're looking for interpretive graphic imagery that personifies the *Omni* viewpoint: science and the imagination applied to a more brilliant future. Think of yourself as a photographer in the year 2081. What subject best captures the age in which you are living? Color quality should be of the highest caliber, and it's important that the subject be concentrated in the bottom two thirds of the photo, to allow space for the *Omni* logo and cover copy.

For this contest we will be awarding special prizes.

The First Prize winner will receive a gold-embossed certificate from *Omni*, $500 in cash, and guarantee of publication.

The Second Prize winner will be presented a silver certificate. The Third Prize winner will receive a bronze certificate.

Here are the rules:

1. Photographs must be original, previously unpublished, and solely your property.
2. You may enter more than once, but each entry must be submitted separately.
3. The competition is open to everyone except employees of Omni Publications International, Ltd., and their families.
4. Color slides. Print your name and address on the slide's border as well as on an accompanying letter explaining the subject of the photo and how the photo was made.
5. Prints. Print your name and address on a small slip of paper and tape it to the back of the print. Put your name and address on the accompanying letter. If possible, enclose the negative as well.
6. We cannot return any photos. So send us something you can part with. If you wish to keep the original, have a duplicate of your slide or print made, and send that.

"Broken Hearts," by Shig Ikeda. February 1980

If your photos are chosen for publication, we will contact you to obtain the original.

7. In order to allow extra time for you to shoot, process, and reproduce your pictures, the deadline for this contest is extended one month beyond the usual closing date for *Omni* competitions.
8. Finalists will be chosen by the Competitions editor, Scot Morris, *Omni* Art Director Frank DeVino, and *Omni* Editor/Publisher and Design Director Bob Guccione.
9. *Omni* will have the right to reproduce all entries in *Omni*, its advertising, promotion and displays, and in shows and exhibits, without limitation. *Omni* will pay its standard fees for editorial use of any entries for purposes not connected with the photography contest.
10. Prizewinning contestants may not permit publication or display of prize-winning photographs without the prior written consent of *Omni*.
11. Entries must be postmarked no later than March 1, 1981 (or March 15 for entries mailed from outside the United States). Pack them carefully and send them to: Omni Photo Contest, 909 Third Avenue, New York, NY 10022.

FORUM

CONTINUED FROM PAGE 14

any evidence at all other than a book written by man were offered I would certainly consider it

Keith Field
Syracuse NY

I am writing in response to Mr Bova's article on creationism [October 1980] I was happy to see *Omni* deal with the subject but as I read the piece my enthusiasm was dampened Mr Bova treated creationism the same way religionists treat evolution if evolution is the logical conclusion drawn from the evidence why not give the creationists equal time? Surely the truth of the conclusion would be apparent Why can't we lay aside our personal doctrines and open an honest debate? Are we more concerned with defending our assumptions than with seeking the truth?

Bill Hathaway
Upland Ind

Ben Bova replies *In any argument over ideas it is prudent to seek out the evidence that can be examined weighed and tested Since before Darwin's time the evidence of evolution has been found in fossils in living organisms and in the development of all life on Earth Creationists in their attempt to use religious mythology as a substitute for evidence do a disservice to both religion and science Genesis is a powerful and moving moral tale But it is not biology and was never intended by its authors to be used as a biology text Render unto Caesar ... is an apt principle for the debate between Creationism and Evolution*

Sexist?

I realize that *Omni* is a science magazine but your fiction stories are ridiculous

The sexist viewpoints that repeatedly come across in these stories are so outdated The awkward inclusion of Henry thought efficient breasts Sparse hard little knockers [Easy Points October 1980] is so contrived and out of tune with the story line as to be laughable

I realize that SF writers tend to lead somewhat socially and sexually isolated lives at least this stereotypical line of reasoning seems to be justified by the sample of short stories I find in *Omni* but please this is 1980 not 1950 Some of us have progressed beyond such blatant attempts at sexual titillation during the last 30 years

Do you want crossover readership from *Heavy Metal* magazine or do you want to be a respected science magazine?

Jeannette Lee Wynne
Richmond Va

Language need not be as simple or straightforward as careless readers make it out to be The fact that a line in a story may reflect a sexist attitude does not mean that the author or editor of the line is sexist or simple Both the author and the editor of Easy Points were women A good writer chooses words not because they are inoffensive or because they are in vogue but because they will have the desired effect The line in question was used for characterization in fact for a kind of double characterization of both Henry and Dano

If you leave behind both your 1950 and your 1980 notions of sex and politics and consider that a writer can write about something other than her own beliefs you might enjoy the fiction more Ed

Perfectly Clear

I don't know what the article Torrents of Babel [October 1980] means

Based on integral subsystems considerations any associated supporting element presents extremely interesting challenges to the philosophy of commonality and standardization in particular a large portion of the interface coordination communication must utilize and be functionally interwoven with sophisticated speech anomalies Conversely a constant flow of effective information maximizes the probability of communication success and minimizes lingual compatibility subsystem testing Similarly initiation of [illegible] tems development necessitates that [illegible] consideration be applied to the [illegible] framework of a given [illegible] apparatus Have I been perfectly clear

[illegible]
New York NY

Games People Play

Question 3 of the Which Lady Wonder Quiz [Games September 1980] compares the longevity of human blood and sperm preservation outside of the body The answer states that blood is stored only three weeks under refrigeration and sperm lasts for years Human blood can be preserved in CPDA 1 for about 35 days or frozen in glycerol for as long as three years Perhaps a better comparison would be between sperm and blood *in the same state*

Pam Marm[illegible] MT (ASCP)
S[illegible] La

And the Winner Is

At long last we can announce the winner of our Ultra short Story Contest sponsored by the European edition of Omni The response was overwhelming More than 750 stories were received by the closing date July 31 The judges of the competition were Dr Bernard Dixon Omni's European editor science fiction writer Christopher Priest Patrick Moore O B E and Angie Burland Omni's European editorial assistant

Ruari John McCallion of Baldock Hertfordshire England is the winner of £500 for his story The Smith and the Stranger The nine runners-up were K J Barnes James Byrne Rob Carter (two entries) David Cleden Les Isbister A Kersh Angus McAllister, Charlotte McDonaugh and Julie McNaughton Each will receive a one-year subscription to Omni – Ed

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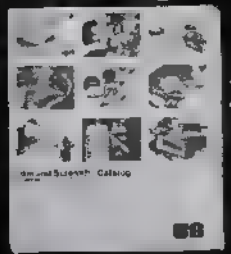

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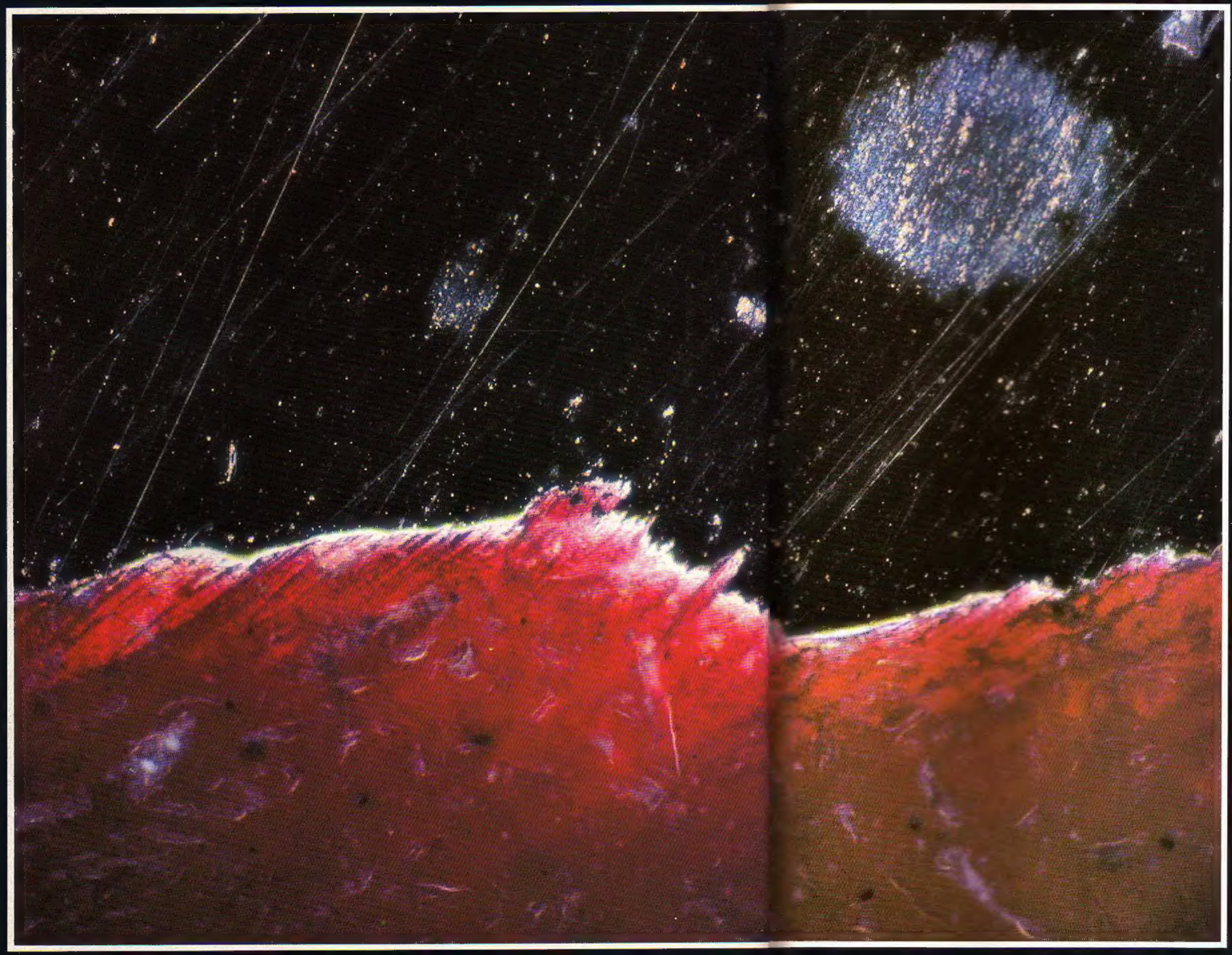


PHENOMENA

Red Martian mountains, a patch of blue moon, meteors streaking the night—components not of outer space but of inner space. A 4,000-year-old Persian bronze fragment, viewed through Space Age optical technology, gives scientists clues to the structure of primitive tools during the Bronze Age. This polished specimen was magnified 100 times by Nicholas Hartmann, of the Applied Science Center of Archaeology at the University of Pennsylvania Museum. A thermosetting resin (red portion of the photo) fuses the granular bronze (black portion) to a mounting medium. The artifact is then etched with acid and inspected for micro-structures relating to the original use of the ore. Occasionally a common feature, such as corrosion (blue portion), can add an eerie beauty to the picture. For this photograph, Hartmann fitted a Pentax MX camera to a Nikon Optiphot microscope set for dark-field illumination. The enlarged image was captured on Kodachrome 64 film exposed for one second.∞

Take a chance on these—
a probability paradox potpourri

GAMES

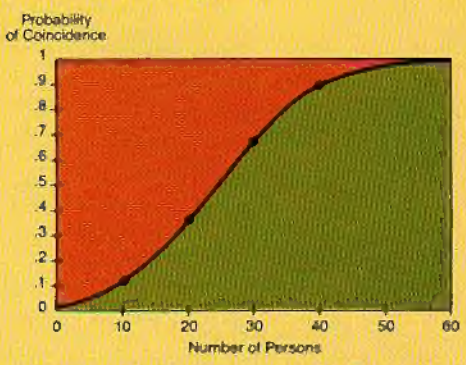
By Scot Morris

Interviewer: *If you had it all to do over, would you change anything?*
Winston Churchill: *Yes. I wish I had played the black instead of the red at Cannes and Monte Carlo.*

Imagine, if you will, a party for the *Omni* editorial department. All of the people listed in the editorial section of our masthead are there, 24 in all (not counting the contributing editors, who are out of town on assignment). If you learned that among those 24 people in the room, 2 had the same birthday (month and day), would you be surprised? How unusual do you think such a coincidence is? How many other such 24-person parties would you have to go to, on the average, before you found another birthday match-up?

Amazingly, the chances are better than 50-50 there will be such a coincidence.

How can this be? Note that we tend intuitively to analyze this problem by asking how likely we are to find someone with the same birthday as our own, but this is an entirely different question. The chance that any two persons, chosen at random, have the same birthday is 1 in 365. (This ignores February 29 and the fact that birth probabilities are not evenly distributed throughout the year. Ignoring leap day lowers the probability of a coincidence; the uneven distribution raises it.) But the chance of a coincidence among 24 persons is much higher because there are $1 + 2 + 3 + \ldots + 22 + 23 = 276$ possible matching pairs.



The graph shows how the probability curve rises with an increasing number of persons, from 0 (coincidence impossible) to 1 (coincidence absolutely certain). The graph crosses the .5 mark when there are 23 persons; at that point the chance of matching birthdays is slightly above 1/2. Note that our graph stops once there are 60 persons, because the probability grows so close to certainty that it becomes impossible to distinguish the curve from the line at the top of the graph. For 100 people, the odds on a coincidence are about 3,300,000 to 1. Absolute certainty is not reached, of course, until there are 366 people in the room.

This month we present a potpourri of probability paradoxes. With each, try your intuition first, your logic second. You may be surprised at the difference. Some questions may at first seem unanswerable in probability terms; approach them from a different angle, and an "Aha!" experience awaits you. Educated guessing is encouraged; exhaustive computations are for mathematical masochists.

1. THE LOPSIDED COIN. You have a coin that you have reason to suspect is unfair—that is, it is biased toward heads or tails, and a long series of flips won't come out 50-50. You want to generate a series of random binary digits—ones and zeros. Can you do it with this coin? How?

2. PENTAGON SPY. A man is standing at a random spot several kilometers from the Pentagon. He looks at the building through binoculars. What is the probability that he will see three of its sides?

3. VIGNETTE.
Census taker: How many children do you have?
Statistician: Two.
Census taker: And their sexes?
Statistician: At least one of them is a boy.

What is the probability that the other child also is a boy?

4. PAIRADOX. If you play poker, you probably have a rough idea of the likelihood that your opponent is holding hands of various value. Suppose you hold a pair. Is the probability that your opponent also holds a pair greater, less, or the same as it would be if you held nothing?

5. BETCHA HALF. I bet half the money in my pocket on the flip of a coin. Heads you pay me, tails I pay you. We toss the coin, hand over the money, and play again. Each time the bet is for half the money in my possession. After a number of rounds I tally my score and find that the number of times I lost was equal to the number of times I won. Did I win, lose, or break even, and by how much?

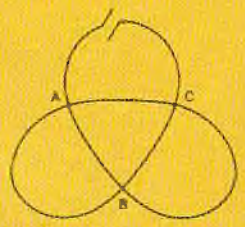
6. TWO STRAIGHT. Leo Moser, of the University of Alberta, in Edmonton, contributed this probability puzzle to Martin Gardner's *Scientific American* column, "Mathematical Games":

Junior asks Dad whether he can have the car for a Saturday night date. His father agrees, with one condition: "Today is Wednesday. You will play a game of chess tonight, another tomorrow, and a third on Friday. Your mother and I will alternate as opponents. If you win two games in a row, you may take the car on Saturday." In the past Junior has won and lost games against both parents but knows that his father is the better player of the two. Which parent should he play first to maximize his chances of winning two games in succession? Should he play father-mother-father, or mother-father-mother?

7. HAT TRICK. After the chess challenge in the above puzzle, Dad felt guilty about holding out on the car; so he offered Junior a bonus on his allowance. Dad was a crafty mathematician, however, and his offer had a twist. He had ten $10 bills, ten $1 bills, and two hats. Junior was to put the 20 bills into the two hats any way he wanted. He would then be blindfolded, would randomly pick one of the two hats, and randomly draw a bill out of it. "If it's a ten, you can keep it," Dad said, "but if it's a one"—and here his guilt was overcome by his craftiness—"if it's a one, you'll wash the car two Saturdays in a row with no complaints." What strategy maximizes Junior's chances of drawing a $10 bill?

8. LICENSE TAG. While you are standing at a bus stop, a gambler offers to wager you that, of the license plate numbers on the next 20 cars to pass you, the last two digits on at least two of the plates will be identical. The gambler, apparently somewhat inebriated, offers to pay $2 to your $1. Should you take the bet?

9. STRING THING. One morning as the probability theorist awoke he saw a shoelace on the floor in the pattern shown below, but his eyes were too bleary to see how the lace crossed itself at points A, B, and C. What is the probability that if he picked the lace up by its tips, he would find it tied into a knot?



10. KIDS. If a couple plans to have four children, which is more likely: (1) two boys and two girls, or (2) three of one sex and one of the other?

11. BIDS. In the strange land of Ultima reverence is given to the *last* of everything. The Ultimans' law says, for example, that a contractor who has a sequence of sealed bids before him must accept, not the lowest bid, but the *last* bid he opens. He is not required to open all the envelopes. Assume that there are four bids, all different, and that the contractor would *like* to accept the lowest of them. What would be his best strategy?

12. CARD MATCH. Shuffle a deck of cards and deal them faceup one at a time while you recite aloud the names of all cards in a predetermined order, for example, ace through king of clubs, followed by the same sequence for diamonds, hearts, and spades. If you had the opportunity to bet even money that in one run through the deck at least one card will be turned up precisely as it is being named, would you take it?

13. SIC TRANSIT. Odds are often computed by considering past performance and assuming the obvious transitive relationship that if A beats B and B beats C, then A beats C. If the Pittsburgh Steelers beat the Washington Redskins last week, and if the Redskins beat the San Diego Chargers this week, then, knowing nothing more, the odds makers would tell you that the Steelers should beat the Chargers next week. Here is a gambling game we offer to play with Jimmy the Greek. We use three fair dice, each with an unusual number of spots on its six faces:

Die A has these faces: 1,1,4,4,4,4.
Die B has these faces: 3,3,3,3,3,3.
Die C has these faces: 2,2,2,2,5,5.

Jimmy the Greek picks one die, I pick another, and we roll for $1,000 bills. The higher number wins. I let Jimmy pick first, fair enough? Which die should he pick?

14. INAUGURAL BALL. Ten senators, all wearing top hats, as they were walking to the President's inauguration, were hit by a barrage of snowballs from a heckling crowd, and all their hats were knocked off. A helpful young page retrieved them and, without asking which hat belonged to whom, gave each senator a hat. What is the probability that exactly nine senators received their own hats?

Answers: page 108.

OLD BUSINESS

Our plea for prizeworthy achievements in the article "Prizes" and Competition #10 (December 1979) brought several unique suggestions that we summarized in the June 1980 issue. Daniel P. Shine, of Cincinnati, imagined a square containing randomly placed points and asked, "What is the probability that any randomly chosen point is the nearest neighbor to its nearest neighbor?" He offered a $100 prize for the solution, and he got a $25 runner-up prize from us for doing it.

The problem has been solved, and the $100 prize has been awarded to Charles Kluepfel, of New York City. The solution is:

$$\frac{6\pi}{8\pi + 3\sqrt{3}} = 0.621505\ldots.$$

Shine received 26 solutions in a few weeks after the June issue came out, and several of them had the correct answer. Kluepfel's was the first received. Congratulations.

Another runner-up prize went to Glenn Jenkins, of Kent, Washington, who asked for a self-contained and self-sustaining environment of living things, plant and animal, that would last long enough to prove that a life cycle had developed. We learned later that this goal has already been reached. Roger James Malyk, a teacher at Centennial Regional High School, in Greenfield Park, Quebec, wrote to say that his school has *four* such ecosystems that are air- and watertight and totally self-supporting. The oldest is eight years old. "They contain abundant plant life and a variety of insect species," Malyk writes. "Sunlight is the only form of direct energy input, and the plants and animals reproduce themselves and have balanced themselves in terms of population size and food supply." We have decided to let Jenkins keep his $25.

A suggestion that got an honorable mention for Charley Lineweaver, of Providence, Rhode Island, was "For a solar-powered ball that will not roll down a hill of 20 degrees or more incline as long as the sun is shining." Tihamer Toth-Fegel, of Santa Clara, California, now claims to have cracked this pressing problem. He sent pictures of a silvery ball, apparently made out of two colanders, resting on an inclined plane. Nice going, Tihamer.

THE FIVE HOUSES. Many readers wrote to say that they had found another valid solution to this puzzle, which appeared in the October issue. When we cross-checked, we found at least 11 legitimate solutions and a few illegitimate ones. For a summary of the response to this problem, write to: Five Houses, Omni, 909 Third Avenue, New York, NY 10022, and enclose a stamped, self-addressed envelope. ∞

LAST WORD

By James Randi

"The delusion of perpetual motion is long and complicated. Yet such notions are suddenly brought to Earth by calculation and experiment."

Of all the citizens of Big Sandy, Texas (population 1,022), none is more famous than William C. Lucas, who was featured not long ago on NBC-TV News as the inventor of perpetual motion. Reporter Bob Dotson said, "They laughed at Fulton and Edison, but they're not laughing at Bill Lucas!" And onto America's TV screens spun the contraption that, according to NBC, generates 4,000 watts of electricity.

Hastening to witness this wonder, I visited Lucas's home in a high state of doubt but quite willing to be convinced.

Lucas had been switching some gears, and his machine was not quite in working order. It rotated and made appropriate grinding and hissing noises, but it would not *continue* to run without being powered from the domestic 110 volts that were used to start it up.

Here's what I saw: A half-horsepower electric motor was run by house current via an underground cable. It turned the shaft of a "gravity wheel" of Lucas's own design. This wheel, operating vertically, had three spokes placed evenly around it, each with a cement-and-iron weight weighing 200 pounds that slid along the spoke. The weights were pushed to the end of the spoke or drawn back to the hub by means of pneumatic cylinders triggered by a cam on the wheel axle as it contacted the respective valves. When a spoke reached a straight-down position, the weight was drawn up to the hub, and a moment later the weight, now beginning its downward trip, was shot out to the end of its spoke. Thus, the wheel rotated under both the force of the motor and the action of the weights providing torque. But where did the compressed air come from that moved the weights? Well, the gravity wheel was connected to an old Toyota transmission, which turned a 500-pound flywheel, which ran a 4,000-watt generator, which put 220 volts into a transformer, which split it into two 110-volt circuits, one of which ran the air compressor. See?

And the other 110-volt line? It ran the half-horsepower motor, once the arrangement was in motion. Lucas claimed that he disconnected the house current that was used to *start* the action, and the small motor then ran on the voltage that came from the generator, run by the flywheel, etc.

That's what Lucas claimed. When I was there, the gearing was not quite right, he said. But there had been an "engineer" present with the NBC team, he told me, who had clapped him on the back and cautioned him not to give his invention away for free. That's all. No validation, no questions, no doubt at all from the engineer. I decided that lacked definition and needed looking into.

I contacted NBC. No outside engineer had been called in, I was told. Lucas had simply disconnected a long wire that ran into the house to prove that the machine ran by itself. That's all they had required of him to prove his claim. But I recalled that Lucas had obtained the house current from a *buried* line. Things were looking very grim for the future of perpetual motion at that point. However, NBC also told me that one of its staff present at the demonstration *was* an engineer from a Tyler, Texas, TV station. I immediately got on the phone to Tyler.

The "engineer" was now in Columbus, Missouri. Undaunted, I called him there. He turned out to be a sports announcer who was "of the opinion" that Lucas's machine worked as claimed. After all, he explained, NBC had powered its TV lights from it. What else do you need?

Lucas, I discovered, has a patent pending on the "gravity wheel." I reached his lawyer, Earl Tate, who informed me that he had troubled to take an honest-to-goodness mechanical engineer out there to see the machine. "No way that thing's going to work!" the engineer exclaimed as they drove back from the show. Tate decided that he'd better ask for a demonstration with everything uncovered, all lines showing, and the provision made for simply pulling the main power switch inside the house to see whether the contraption would keep on going.

Looking at the Lucas "invention," we discover that he has reinvented the flywheel, the unbalanced wheel, and compressed air. Surely he loses the majority of the power that he puts into it, through transference and through friction. If it's 5 percent efficient, I'll be surprised. And—of greater interest—I find that an examination of his patent-pending papers shows that no provision is made for disconnecting the initial 110-volt motive power! Shooting weights out to the end of spokes to cause a wheel to turn provides no advantage at all. Yet a patent attorney in Washington, D.C., accepted Lucas's money to have these papers filed.

The history of the perpetual-motion delusion is long and complicated. Machines similar to the Lucas assemblage have been begging for patents ever since the Patent Office opened for business. Every amateur has figured that running a generator from a motor run by that same generator would be a dandy idea. Yet such notions are deflated suddenly by both calculation and experiment. But that doesn't stop the inventors—or the investors. Just after NBC-TV News ran the Lucas story, the FBI arrested a Texas citizen named Arnold Burke for selling $800,000 worth of stock in a similar type of wheel he had named Jeremiah 33:3, for reasons that I will allow my reader to discover. Burke was found to be using a small motor to "help" the device along. He claimed to get 3,000 kilowatt-hours per month from his wheel—and may get a few years in jail, too. ∞

James Randi's newest book is Flim-Flam: The Truth About Unicorns, Parapsychology, and Other Delusions *(Lippincott and Crowell, 1980).*